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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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The Patternmakers' Foundry Sense.

In the mental equipment of the really first-class patternmaker—he whose work, besides being correct in dimensions, embodies every possible aid likely to facilitate production—there seems to be an ever-watchful and active faculty holding a brief, so to speak, for the foundry. This faculty both prompts and criticises from the foundry point of view. Its development is, therefore, of the highest importance in the making of a patternmaker. Omitted, the most complete training in the handling of tools and pattern construction, *per se*, with special attention to blue-print reading, will not suffice to produce even a mediocre workman.

The ultimate object of patternmaking is the production of *castings*—not patterns. This axiom is often lost sight of. The pattern is, essentially, an instrument or guide. Its effectiveness as such is the real measure of its intrinsic worth. When it hinders—as in the case of impossible joints—or contains ambiguity—as, for example, where similar points receive dissimilar cores—it fails in its function as guide. Obviously, a casting consigned to the scrap heap is equally a dead loss, whether its rejection is due to a wrong impression being left in the mould or on the mind of the moulder. Moreover, the usual excuse resorted to in the latter case, that it was an oversight, aggravates rather than minimises the error.

Of course—to vary the old saying—some are born with the "foundry sense"; others acquire it: and a few have it thrust upon them. In whichever category he may find himself, however, it is in the interest, as well as the duty, of every aspirant to patternmaking honours, who desires the good will of his foundry confrères, to grasp every opportunity that offers itself for the cultivation of this part of his craft.

The function of the patternmaker is to translate design into terms of foundry practice. As in the case of language translation, an intimate acquaintance with the atmosphere into which the original idea is to be translated, is quite as essential as is a mastery of the language in which the idea is clothed. Indeed, it is more essential.

How is the budding patternmaker to develop this "foundry sense"? Actual foundry experience, carried on *pari-passu* with his work in the pattern shop is, perhaps, the ideal method. First-hand experience, however, is generally out of the question, for immediate economic reasons. But there are other methods. Pertinent questions and careful reflection over the experiences that his foundry friends are good enough to relate to him; a real avidity for their criticism of his work, and an eagerness to sense their requirements will do much to make good the deficiency. It is a debatable point, indeed, whether this latter method does not conduce to the best results, for though experience is the best teacher, according to Jean Paul Richter, her fees are very high and her methods dilatory. With a wide range of experience from which to gather the student will probably assimilate data at a much greater rate than if he depended upon his own personal experiences alone. His "foundry sense" becomes, in this way, more varied and comprehensive.

Close attention to the reports of the various trade institutions published in the foundry technical Press will appreciably extend the patternmaker's horizon, enabling him to anticipate the up-to-date requirements of the foundry.

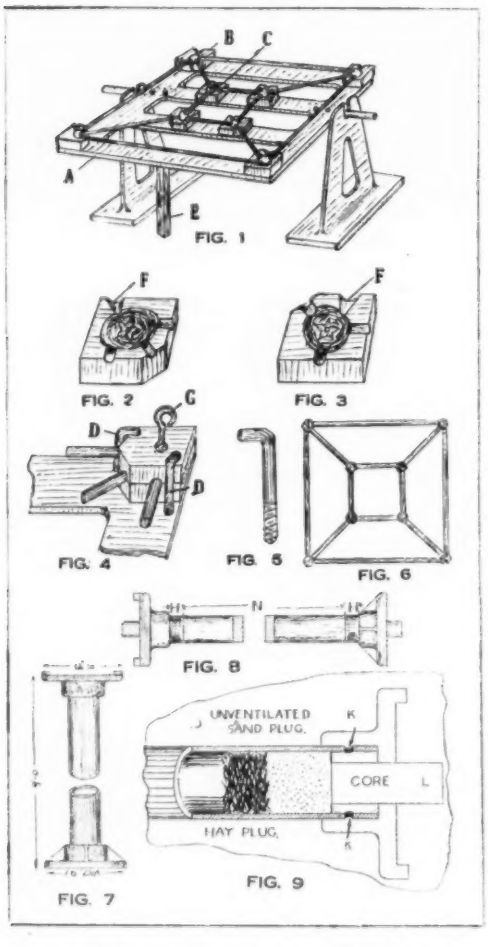
It is both instructive and pleasurable to watch one's pattern withdrawn from the mould without disturbing the latter; to see the cores go together like the proverbial clockwork; and, subsequently, to run a critical eye over the casting itself. This paternal interest—in keeping, by the way, with the fact that patternmaking is a creative art—is, perhaps, the most important stimulus in the evolution of the "foundry sense."

As his mind becomes saturated with foundry lore, the patternmaker will regard his work more and more from the foundry point of view, and by visualising the various moulding operations as he proceeds his work will not only become more interesting to himself, but less troublesome to the foundry. Finally, just as a sense of humour is invaluable in the ordinary affairs of life, so we may say with equal truth that, in patternmaking, a well-developed "foundry sense" is often the saviour of the situation.

"Casting-On" Processes.

By F. C. Edwards.

There is scarcely a branch of the engineering industry in which "casting on," in one or other of its varied forms, cannot with advantage be employed. The two principal objects of "casting on" are: (1) As a means of joining or tieing together several units to form a composite whole; and (2) to secure a combination in one component of the peculiar qualities of two or more metals; say, for instance, cast iron and wrought iron and steel. In the former capacity "casting on" is used very extensively in the manufacture of bedsteads, window frames, hand railings, etc. Here wrought-iron bars of light section are literally cemented together by the cast iron, which is also made to serve as a medium for ornamentation. In the second category we may include cast-iron ball or bar weights, with wrought- or malleable-iron eye-bolts, columns of bar or tube section with bases and capitals of cast iron, and innumerable forms of ornamental work.



There are, of course, many other applications of "casting on." Wherever it can safely be utilised, it will generally be found to have an appreciable effect in cheapening production. The casting together of iron and copper, iron and steel, and iron and gunmetal is a common practice in some classes of work, and in this direction there is undoubtedly a wide field in which "casting on" could be advantageously exploited. It is, however, beyond the scope of this article.

A common practice in "casting on" is to make a complete iron pattern, from which sand moulds are obtained. This method is obviously inferior to that in which permanent cast-iron chill-moulds are used. An example of the latter is illustrated in Figs. 1 to 5. Fig. 6 shows the finished product—a simple specimen of wrought-iron railing. In Fig. 1 the frame A is seen with the wrought-iron rods in position, and the top halves of the moulds removed. Figs. 2 and 3 show the bottom-half moulds B and C respectively; Fig. 1 drawn to a larger scale and minus the rods. Fig. 4 illustrates the top right-hand corner of the frame, with rods and the top-half of the mould in position, clamped and ready for casting. As will be seen from Fig. 5—which is an enlargement of D, Fig. 4—the holding down clamps are simple, easily adjusted (a single half-turn secures or releases the moulds), and, being screwed into the frame, they cannot get mislaid.

The sequence of operations is as follows:—Wrought-iron rods are cut off to the required length and laid in the moulds, and the top half-moulds placed in position, being correctly located by the rods. The clamps, D, Fig. 4, omitted from Fig. 1 in order to avoid confusion, are given half a turn, thus gripping the moulds firmly together. The prop E, Fig. 1, is removed, and the frame swings on its trunnions to a vertical position. The moulds are then poured in succession, the gates being arranged as at FF, Figs. 2 and 3. The frame is again propped up to its original horizontal position, the clamps are turned back, and the top half-moulds are removed by means of hook G, Fig. 4. The railing, Fig. 6, is then lifted out complete. The cycle of operations occupies less than five minutes.

Different permanent moulds are required, of course, for the different kinds of work. The frames, it may be added, are cast iron, and of light section, say, $\frac{1}{2}$ in. × 4 in. The moulds are secured by studs. The wrought-iron trunnions are bolted on near the top of the frame to allow the latter easily to fall into the vertical position necessary for casting.

Figs. 7, 8 and 9 illustrate the process of "casting on" in the case of columns and similar objects. The finished column is seen in Fig. 7, which represents a 4 in. dia. steel tube with a cast-iron base and top support bracket to carry girders. Fig. 8 shows the pattern. It is to be noted that the parts "H," which are of the same diameter as the tube to be cast on, extend merely a couple of inches or so beyond the bosses. They are, of course, the points for receiving the tube. The intermediate portion, "N," acts simply as a stretcher holding the flanges the proper distance apart. The top halves are dowelled in position, and are separate to facilitate withdrawal in the cope. Fig. 9 illustrates one end of the mould with the tube in position. Cut to the required length, the tube is drilled near the ends, as at K K, to assist cohesion. Four, say, $\frac{3}{4}$ in. dia. holes would be suitable for the case under consideration. The tube is then tightly plugged at each end. This is done not only to prevent the molten metal from entering the tube, but also to guard against the possibility of an explosion by the gases, evolved at the moment of pouring, driving inwards. In some cases, however, a small hole is drilled near the centre of the tube to provide a means of egress for the gases. Lack of sufficient attention to this matter has been the cause of many serious accidents. In the smaller dia. tubes, say, up to 2 in. dia., moist sand alone may be rammed in sufficiently tight. Care in handling, however, is imperative, or the sand may become loosened. In the larger sizes it is advisable to insert first a tight-fitting plug of hay, or similar material, as shown in Fig. 9. This prevents the sand from becoming dislodged. The sand plug should be, say, 4 in. in thickness, and *must not be vented.*

The ends of the tube that are to come in contact with the molten metal should be coated with a mixture of red lead and paraffin or turpentine. If this is not done the molten metal does not lie quietly round the tube, and the casting will be found to have appreciably thickened up—probably in the form of unsightly laminations. The tube is laid in the mould and the dry-sand core L, Fig. 9, is forced tightly against the sand plug. It is advisable to cast the job as soon as possible after laying the tube in the mould.

Institution of British Foundrymen, London Branch.—The following officers have been elected for session 1922-1923: President, Mr. Wesley Lambert, M.I.C.E.; senior vice-president, Col. W. F. Cheesewright, D.S.O.; junior vice-president, Mr. G. C. Pierce; secretary, V. C. Faulkner, M.I.Met.; assistant secretary, J. Longden; members of Council, Capt. A. E. Harford, and Messrs. Bowman, Brown, Cleaver, Cole-Estep, Cooper, Hall, Hand and Shaw; delegates to the General Council, Col. Cheesewright, and Messrs. A. R. Bartlett and H. O. Slater.

Imperial Steel Works, Sheffield.

The business of Edgar Allen & Company, Limited, was founded by the late Mr. Edgar Allen, Mr. Robert Woodward and Mr. Alfred E. Wells in 1890, when they acquired what had formerly been a wagon works at Tinsley, Sheffield, and converted the existing buildings into a small foundry, consisting of pattern shop, foundry and machine shop.

Fig. 1.—General View of Foundry, showing Service Track.

In the early days melting was done in crucible furnaces, the plant being equal to the production of castings up to 5 cwts. From the outset the Company laid themselves out for the production of high-class steel castings for the colliery, agricultural and general engineering trades.

Needless to say, it soon became necessary to increase the capacity of the melting plant, and this was about the time of the advent of the Robert converter. After, however, giving this careful consideration, the management decided such a plant was useless for their purpose. In the meantime, Mr. Tropenas (formerly with Robert) had come into this country, and, receiving the active co-operation of Messrs. Edgar Allen, he designed his now well-known converter, the initial plant being installed at the Imperial Works. A new foundry was added to the works in 1891, and a second Tropenas plant put down, thus enabling the Company to produce castings up to 2 tons in weight.

In 1904 the Company acquired the business and plant of Messrs. Askam Brothers & Wilson, which was transferred to the Tinsley Works in 1905-6. In the meantime, repeated extensions made to the original works had filled the whole of the available site of 4½ acres. Not the least interesting of the additions to the melting plant was the installation of a 5-ton open-hearth furnace, in which steel was made upon a basic hearth and refined in a single-phase 50-cwt. Héroult electric furnace. This furnace was the first of its kind to be installed in this country, and it is worthy of note that it was kept in full operation during the years of the war, being quite recently put out of commission, and replaced by a modern three-phase furnace.

Anticipating future possibilities, the Company acquired, in the early days of its operations, about 15 acres of land on the opposite side of the main road to the original works, and, separated from this last by the canal, they have 22 acres occupied by a modern works for the manufacture of points and crossings, cement plant, crushing plant, etc. At the time these sites were purchased they were agricultural land.

During the war part of the old works was laid down as a forge, and this, in point of fact, is still in operation. The ultimate intention of the Company, however, is to rebuild entirely this side of the works, and it is here that their head offices are situated.

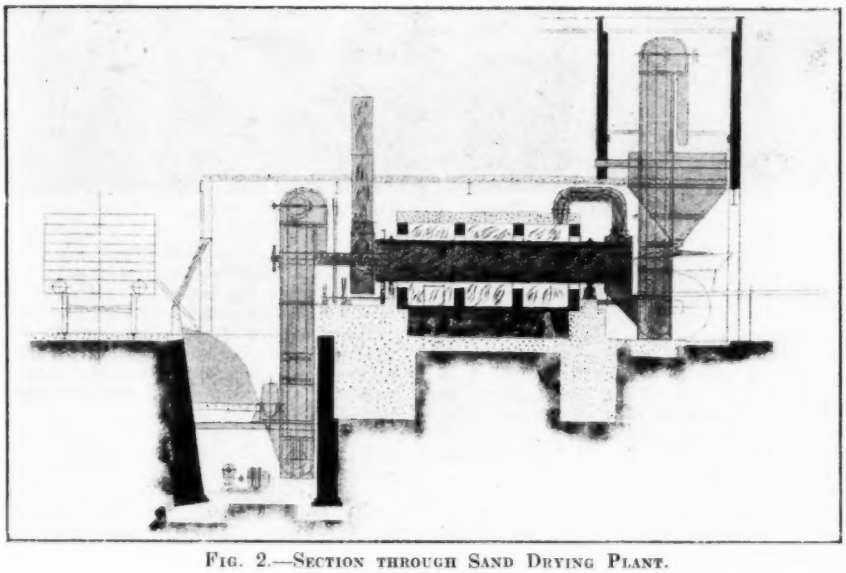


Fig. 2.—Section through Sand Drying Plant.

The new works are entirely self-contained, with managerial staff and clerical offices, etc. The new foundry is entered by a gateway, on the one side of which are the offices and on the other the general stores. The shops themselves are surrounded by extensive yardage accommodation, which is traversed by a network of standard double track, turntables at intervals enabling the railway trucks to pass completely through the whole of the shops. The internal transport facilities are indeed quite

exceptional, all possibility of congestion being eliminated.

The pattern shop is a lofty, well-lighted building, the floor being laid with concrete faced with 2½ in. of asphalt and covered with boards. The equipment includes two band saws, two circular saws, two planing and thicknessing machines, sand-papering machine, nibbling machine for template making, lathes, tool grinders, etc. All machines are driven by belt from line shafting placed below the floor. There is a side gallery for pattern storage, and here also is the foreman's office. The whitemetal shop adjoins, and is served with a gas-fired crucible furnace of 3-cwt. melting capacity. From the pattern shop the patterns are passed to the laying-out room, which adjoins the foundry.

Before dealing with the foundry in detail, it may be well if we refer briefly to the general principle of the lay-out. The heavy foundry, which commenced operations in October, 1914, consists of two 50-ft. span bays, divided by a central connection way 20 ft. wide. Along this latter passes all the traffic necessary for the service of the moulding shop, including steam jib crane, full-sized railway trucks, and the overhead system for delivering facing sand to the moulders. The extension to this foundry, built since the war, consists of a main bay 50 ft. wide, which is really the main bay of the heavy foundry extended, the total length of the bay being 1,000 ft., with seven 30-ft. span side bays running at right-angles to it. Each of the side bays is equipped with a 3-ton crane, the runways being so arranged that they pass under the main crane girder of the main bay, so that the cranes serve to pick up the ladles of steel required for the casting work produced in the side bays.

The whole of the foundry department is so planned that every operation on the castings is carried out in a separate shop, thus permitting the greatest specialisation in detail and preventing delays which often occur when two sets of men want the crane at the same moment. The castings pass by four different routes according to convenience, from the moulding shops direct to the annealing shop. Parallel to the annealing shop runs the rough fettling shop, whence the castings, after shot-blasting and chipping, are despatched to the smiths' shop, machine shop, or the finishing fettling shop, as the case may be. From the last-named the castings pass to the delivery department, which is served by two lines of railway communicating direct with the main line.

Before passing to the sand-mixing shop, which is at one end of the foundry, the bulk of the sand goes through a dryer. This dryer, which was constructed by the Company's Cement Department on the lines adopted for drying coal, consists essentially of a steel tube fitted internally with straight and spiral baffles for turning and propelling the sand respectively, which is suspended in a coke-fired furnace, the flames from which circulate round the tube, whilst the waste gases enter the tube at the delivery end and pass through the tube to the chimney. The sand is fed to the dryer by a bucket elevator and delivered into a similar elevator, which last feeds it into an elevated bunker, from which it is loaded into wagons. The plant is capable of drying one ton of sand per hour with a fuel consumption of one cwt. of coke per ton.

The sand plant is housed in a pit, at the rear of which are ten storage hoppers for the various grades of sand. The mixing plant comprises four units, each consisting of a mill, elevator, disintegrator and delivery shute. Each unit, driven by an 18-h.p. motor, treats 30 cwts. of sand per hour, and delivers it into pans of 10 cwts. capacity, which are conveyed by the overhead system already mentioned to the bins for the various machines. These bins are provided with a telescopic shute which is pushed out over the track for the reception of the sand, and can then be moved inwards so as to leave the central way free of all obstruction. A special mill is provided for core sand.

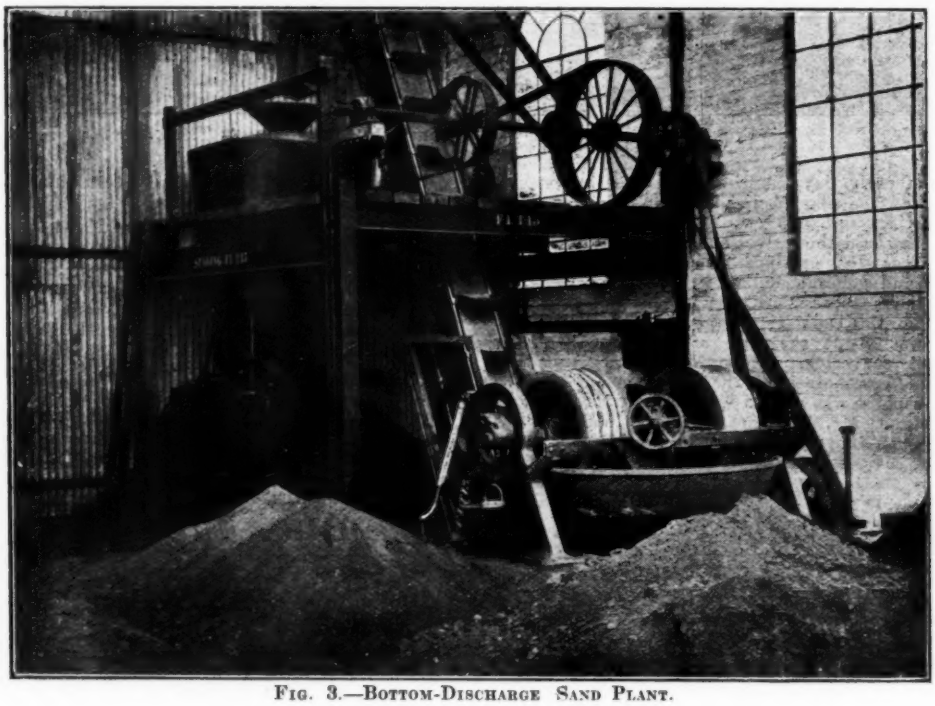


Fig. 3.—Bottom-Discharge Sand Plant.

The two bays of the heavy foundry are devoted to the production of heavy and medium and medium and light castings respectively, the total moulding shop area of the foundry being approximately 146,240 sq. ft.

The melting shop in the heavy bay is served by a Vaughan & Broadbent 10-ton crane. The plant comprises a 10-ton and a 3½-ton Stobie electric furnace, which work melting and refining respectively, the last-named giving one charge per hour. A very liberally proportioned charging platform is provided, at one end of which is the foundry laboratory. A mid position in the melting shop is set off for the tarring plant for dolomite and silica bricks, and for the storage of scrap.

Continuing the melting shop, there is a Héroult 3½-ton electric furnace, furnished with the Watford complete automatic control. There are also two complete converter units, each comprising a 10-ton cupola and two 3-ton Tropenas converters. The cupolas are blown by Keith-Blackman fans driven by 60-h.p. motors, whilst blast is supplied to the converters by Roots blowers, which are each driven by a 150-h.p. Sandycroft cascade motor. Push-button control is provided in a house placed between the two units. The units are worked alternate days, and are capable of bringing down

70 tons of molten metal a day. The charging platform, common to both units, is extended so as to provide for storage of ganister, etc. A furnace hoist has been dispensed with and its place taken by two Broadbent 50-cwt. overhead cranes, which, with a hoisting speed of 60 ft. per min., deliver the weighed charges direct to the platform. The ganister being discharged direct from the railway wagons, the melting shop is laid with a double set of track, with run-outs at intervals. Tandem with this shop is the bucket repair and heating shop, the floor of which is served by a Vaughan 5-ton crane.

The heavy casting bay is served by six overhead cranes with lifting capacities ranging from 5 to 25 tons, and there are in addition a large number of jib cranes, which are carried on the central pillars, so that within their radius they serve either bay. The machine equipment includes four Whittaker wheel-moulding machines and a 16-in. and an 11-in. Tabor shockless jarring machines. An interesting job on one of these machines at the time of our representative's visit was a coal-cutter casing.

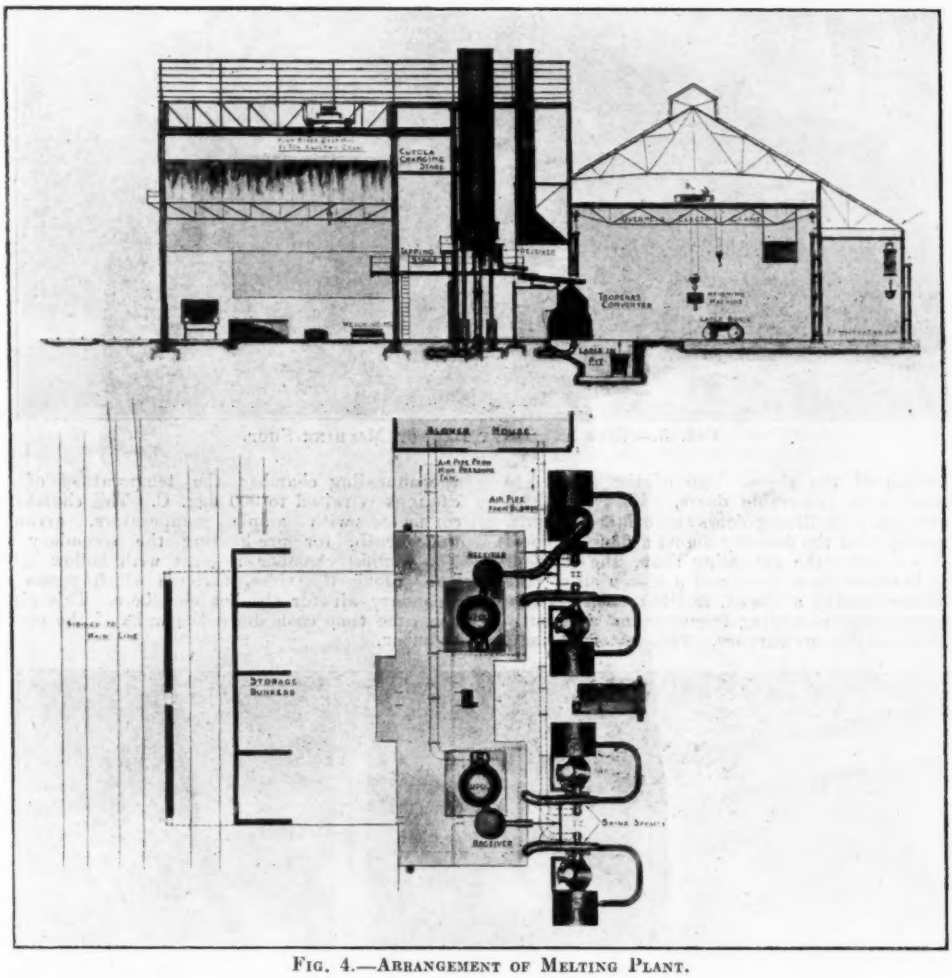


Fig. 4.—Arrangement of Melting Plant.

The main casting pit is 24 ft. × 24 ft. × 8 ft. deep, and in the centre of this is a second pit 12 ft. × 12 ft. × 20 ft. deep from the floor level. The floor of this second pit is carried by channels in such a manner that it may be locked, as to depth, in four different positions. There are four large bogie and three core stoves, which are all gas-fired.

Adjoining the main bay is the electrical and mechanical repairs shop served by a 5-ton Vaughan crane. The tool equipment includes lathes, drills, slotter, shaper, planer, etc. Here practically the whole of the works plant repairs are carried out, so that the works are actually independent of the machine shop.

The medium and light bay runways carry three 3-ton Vaughan and two 5-ton Booth cranes. The machines installed include a Tabor shockless roll-over pattern-drawing machine to take boxes up to 3 ft. × 2 ft. 6 in.; 4 Britannia machines to take boxes up to 28 in. square, and 24 hand-rammed stripping machines. Housed in the side of the bay are the core shops, provided with 3 small jarring machines, and the power house, in which are installed two Belliss compressors of 400 cub. ft. capacity at 80 lbs., each driven by a Sandycroft 45-h.p. motor. The units are provided with automatic cut-outs. The stoves, comprising three pairs fired with town's gas, are also placed in the side of the bay.

A separate sand-mixing plant has been installed for the foundry extension. This is of a new design evolved by the Company, and for the time being is more or less in the experimental stage. It comprises a mill discharging centrally into a bucket elevator, which feeds a vertically disposed disintegrator. From this last the sand passes to the storage hopper, being conveyed thence by electric truck to the moulding floor. The arrangement has proved entirely successful.

As already stated, this foundry constitutes on the one side an extension of the heavy bay and on the other side seven bays, each of 30 ft. span, which run at right-angles to the main bay. In each bay there are four Britannia machines, as also a number of Universal squeezer machines, most of these last having been modified to meet shop requirements; thus several are arranged to strip downwards. Each bay is worked by a gang of men on piecework basis. The crane men and the labourers also get 10 per cent. on output. There are three core- and mould-drying stoves of the town's gas-fired type, these being the latest design of Messrs. King, Taudevin & Gregson, Limited, Sheffield. The internal dimensions vary from 14 ft. to 11 ft. wide and 23 ft. 10 in. long. They are fired from gas rails along each side of the furnace, being fitted at each connection with a special type of atmospheric burner provided with a primary air regulator and control cock; the

secondary air is admitted underneath. A small combustion chamber is built into the side walls of the stoves at about 2-ft. centres. The roof is built in brickwork arches, a skewback of which is carried inside rolled-steel joists spanning the full width of the stove. Two of the stoves are provided with removable doors, whilst the third is equipped with lifting doors and balance-weights.

Passing from the foundry across a double line of track we enter the annealing shop, the floor of which is served by a 5-ton and a 15-ton crane, the last-named having a 15-cwt. auxiliary hoist. There are seven large annealing furnaces and a recently installed continuous furnace. This latter furnace, designed and built by Messrs. King, Taudevin & Gregson, Limited, calls for a brief description. It consists of three chambers—pre-heating, intermediate annealing, and a cooling chamber—the respective lengths being 15 ft. 2 in., 14 ft. 1 in., and 15 ft. 2 in. × 9 ft. 9 in. wide and 7 ft. 6 in. high above the bogie. Each chamber holds one bogie, the chambers being separately sealed with intermediate sliding doors which seal on the ends of the bogies, and the bogies being sealed longitudinally in the usual way with sand troughs. The furnace is fired with producer gas. The pre-heating chamber heats the castings to 700 deg. C., and is supplied with warm air from underneath the bogie and secondary air for combustion. In the annealing chamber the temperature of the castings is raised to 900 deg. C. This chamber is connected with ample recuperators, arranged underneath, for pre-heating the secondary air. The cooling chamber is built with hollow muffle walls along the sides, through which passes the secondary air for the hot chambers. This air at the same time cools down the walls of the cooling chamber.

Producer gas flues are built along each side of the furnace, and mushroom valves with the ordinary columns are fixed for controlling the gas supply to each side of the pre-heating and annealing chambers, these flues being connected together under the cooling chamber to the main supply. The bogies and intermediate doors are carried upon roller bearings, the end doors being provided with lifting hooks for removal by the overhead cranes. The intermediate doors are of rather a

Fig. 5.—View in Heavy Bay of Machine Shop.

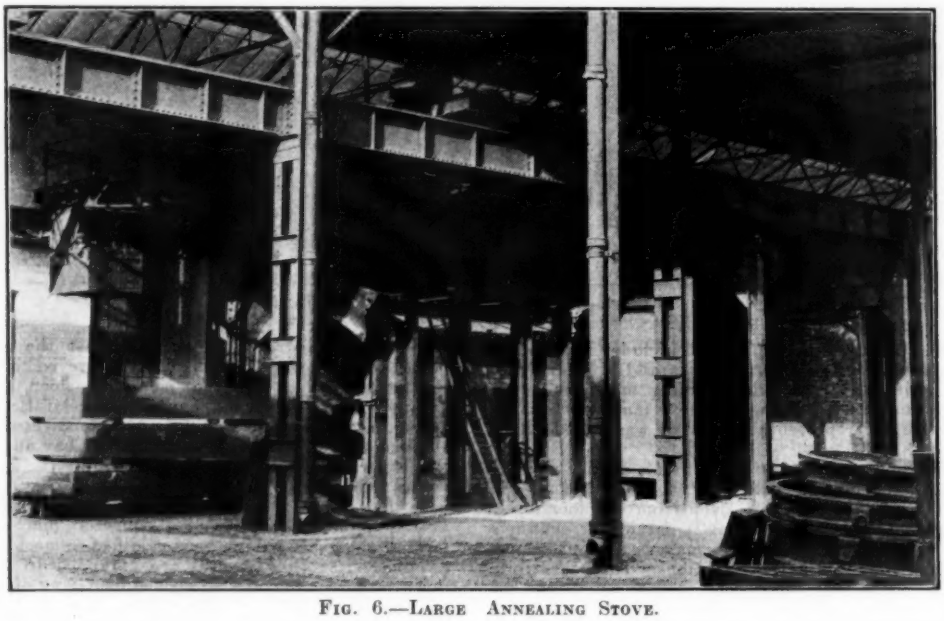


Fig. 6.—Large Annealing Stove.

novel construction, with cast-iron and steel framework suspended upon rollers running upon a joist carrying the whole structure. The doors are sealed overhead with sand seals across the roof of the furnace, the bottom of the door sealing being alternately in each end of the charging bogies. Although the total weight of the doors is 5½ tons, they are easily moved in or out to pass the castings from chamber to chamber. The pre-heating chamber is so designed that for a certain class of work it may be used as an annealing chamber. The recuperator is of the King, Taudevin & Gregson tile pattern, which they have adopted almost exclusively in their heavy furnaces.

The charging and discharging facilities of the furnace are very well arranged. The furnace occupies a total floor space of 48 ft. × 20 ft. Up to the present, from 20 to 25 tons of castings have been annealed on each bogie per 24 hours. Gas for the annealing shop is supplied from a battery of three 12-cwt. Morgan producers.

Fettling is done in a shop parallel with the annealing shop. In the fettling shop there are ten Tilghman's shot-blasting rooms; there is a full complement of pneumatic tools, as also an oxy-acetylene installation. The floor is served by a 5-ton and a 15-ton crane.

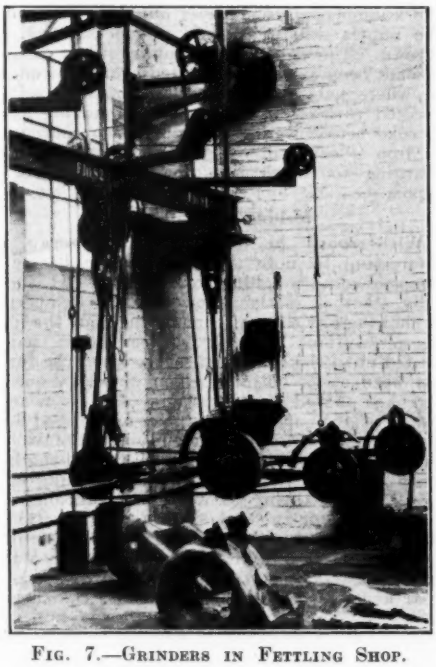


Fig. 7.—Grinders in Fettling Shop.

The smiths' shop, 500 ft. × 25 ft., has an installation of Pilkington hammers, comprising a 10-cwt., two 5-cwt. and a 3-cwt., which are operated by a Pilkington compressor of 600 cub. ft. per min. at 80 lbs., driven through a Brown reduction gear by a Siemens 130-h.p. motor. Air receivers are installed at either end of the shop.

The fettling shop extension, laid out particularly to handle small parts and thus balance the extension to the foundry, is contained in a building 58 ft. × 45 ft. The equipment comprises swing grinders, in connection with which is a complete dust-extracting plant.

From the fettling shop we enter the straightening shop, in which is installed a 100-ton press fitted with top and side rams, and served by two coal-fired furnaces.

Next in order is the finishing fettling shop, a building 175 ft. × 42 ft. 6 in., in which are installed twelve swing grinders and ten double-head grinders, fitted with dust-extracting plant. Oxy-acetylene cutting plant is also in service.

The Company were amongst the first to recognise the importance of finishing the castings at the seat of production, so far as possible, and they have for a considerable time made a speciality of finished machined castings, the machine shop being specially laid out for that purpose. The machine-tool installation includes a range of seven Noble & Lund band sawing machines; circular sawing machine, with vertical feed; Greenwood & Batley grinder; Norton external grinder; Jones & Shipman internal grinder; 14-in. double-head lathe, with gap bed; Noble & Lund 36-in. gap lathe, with all-geared head; three Butler planers, fitted with the Lancashire drive; Kearns universal machine; Dean Smith & Grace lathes and shapers; Butler slotters; Geo. Richards 7-ft. vertical boring and turning mill; Butler 6 ft. 6 in. double-head lathe, each head driven by a 20-h.p. variable-speed motor; 5-ft. centre facing lathe; Butler shafting lathe, etc. The whole of the line shafting runs in Skefko ball-bearings, the driving motors being carried on elevated pedestals.

Provision is made for testing hydraulically up to 5 tons per sq. in. cylinders and other similar parts. The shop is capable of turning out 250 tons of finished castings per week. As a matter of fact, the total weekly output for the year ending March last averaged 225 tons, this being the net weight of castings actually despatched to customers.

Americans Establish Customs of the Trade.

One of the most important matters to come before the first annual meeting of the Ohio State Foundrymen's Association, held on March 31, was the report of the committee on uniform foundry practice. The committee had sent out questionnaires to foundrymen throughout the State and the report was based on the answers received. Considerable discussion ensued and a number of changes were made in the committee's report. The meeting decided that it would recommend to its members the adoption of the following trade customs:—

1. Patterns to be in condition to make castings of the quality and quantity required.

2. Correctness of patterns and core boxes to blue prints rests with customers.

3. If patterns require stopping-off, or skeleton patterns are furnished, an extra charge will be made.

4. Any expense due to incorrectness of patterns and core boxes shall be borne by customers.

5. Repairs and changes in patterns by customer's orders at expense of customer.

6. Patterns to be painted in three colours showing core in red, machine surface in yellow, and rough casting in black.

7. All patterns, core boxes and loose pieces thereof should be properly numbered for identification.

8. All freight, drayage, boxing and crating, to and from foundry, on patterns, at expense of customer.

9. Foundry not responsible for loss of or damage to patterns by fire or theft.

10. Patterns not in use for a period of six months may be subject to storage charges.

11. Defective castings to be replaced by the foundry free of charge, if reported within a reasonable length of time.

12. Foundry not responsible for any expense incurred by customer on defective castings.

13. Claims for error in weight or number to be made within five days after receipt of castings.

14. Boxing, crating or bundling of castings not specified in contract are at the expense of customers.

15. All castings are sold as rough castings f.o.b. foundry unless otherwise stated.

16. In case customers require special production service to secure quick delivery, an extra charge shall be made.

17. Customers to be charged with cost of cores and moulds discarded due to change in patterns or core boxes.

18. All changes in orders of any description must be made in writing.

19. Foundry shall not be liable in damages for failure to deliver, caused by strikes, differences with employees, accidents at foundry, or other causes beyond their control.

20. Cancellations of orders are to be by mutual consent only.

21. Unless otherwise agreed, quotations are for acceptance within 30 days.

Cupola Practice.

By J. Wood (of Wakefield).

(*Continued from page* 290.)

Sulphur Prints.

A quick and reliable method of testing for sulphur is by means of sulphur prints. These prints enable one to determine the sulphur in iron to within a fair degree of accuracy. As the effects of sulphur on cast iron are many, and its influence is great, these prints often impart valuable information to the person concerned. When a sulphur print is desired a piece of iron casting or pig is taken, and a smooth surface obtained either by machining or an emery wheel, taking care to have the surface free from grease and dirt. A 3 per cent. solution of sulphuric acid is then prepared. A piece of ordinary bromide photographic paper the size required is now dipped in the acid and then pressed in close contact with the smooth surface of the iron, and held there for 30 seconds or 60 seconds as desired. The acid causes the sulphur to leave the iron in combination as a gas, which acts upon the bromide in the paper, producing dark or light sepia tints corresponding to the distribution of sulphur. The print is then washed in water and fixed by washing in Hypo solution. If a series of these prints are made, say from 0.025 per cent. to 0.125 per cent., the laboratory estimation corresponding to each print being known, and are used as a standard, then any iron that comes along whose sulphur content is in doubt, a print can be taken and the sulphur determined approximately by comparison of colours.

Coke Beds.

A most important factor in the melting of iron satisfactorily is the coke bed. The depth of this will vary according to the diameter of the cupola, the amount of air delivered and the quality of coke, but it must be made and maintained at a sufficient height above the tuyeres to prevent the iron coming in contact with the blast. The size of the coke bed should not be determined by weight, as it is a fact that some cokes are heavier than others, and a big difference in the depth of the bed will take place if judged by weight. Moreover, even if only one quality of coke were used the cupola lining is gradually lessened after successive meltings, and the weight of coke that would be suitable for a newly lined furnace would not be sufficient for the same furnace after several days blowing. Therefore the safer plan is to have an iron rod cut to the required length, then by inserting it through the charging door the depth of the bed may be ascertained. When the bed is made of the desired height the charging can be commenced. The author's practice is to charge 20 cwt. of pig-iron and scrap, the amount of scrap will depend on the quality of pig-iron used. The pig-iron is charged first and placed as evenly as possible upon the coke bed, the scrap is then spread evenly upon the pig-iron; coke is then spread evenly over this. The process is repeated until the cupola is filled level with the bottom of the charging door. The chief point when charging the furnace is to see that the correct amount of pig-iron, scrap and coke is charged, and to ascertain that they are distributed as evenly as possible.

Chambering.

There are very few furnace-men who have not at one time or another experienced the chambering of the cupola. This is usually due to the coke bed or a portion of it being burned too low, probably through one or more of the following causes, namely, charging too heavily; charging the metal down the side of the cupola; uneven distribution of coke, *i.e.*, leaving part of the iron charged uncovered with coke, or charging heavy lumps of scrap. Any of the above irregularities are likely to originate the chambering of the furnace. Cupola chargers, as a rule, are not long in finding out that the metal melts much quicker at a red or yellow heat than it does at a white heat, and where large outputs are required they are apt to take advantage of this knowledge and charge more heavily than they should. Of course, where weighing machines are installed there is less likelihood of this happening. Assuming that the charges of iron are out of proportion to the coke charged, that is, supposing only sufficient coke was put on to melt 10 cwt. of iron, and either through a mistake or otherwise 12 cwt. were charged, then what happens is—there will not be sufficient coke charged with the iron to melt the whole of it, the remainder has to be melted with the bed coke, with a consequent lowering of the bed and also a lowering of the temperature of the iron, and each successive charge as it enters the melting zone will use up a portion of the bed coke until it gets so low that the iron is close to the tuyeres and the cold blast will blow upon and chill it. It then sticks to the sides of the cupola immediately above the tuyeres, and any molten iron that drops upon the chilled iron becomes chilled in turn and so gathers, and if steps are not taken to stop it it will soon extend across the cupola and preclude further melting for the day.

The same effect may be caused by charging too much iron down the side of the cupola, only with this difference, when the charges are too heavy the whole of the coke bed is lowered and the chambering is commenced all round the cupola. When charging down one side the chambering commences only on that side of the cupola where the bulk of metal has been thrown. The same thing applies when the coke has not been evenly distributed over the iron, that is, where part of the metal charged is left uncovered with coke, and instead of having a layer of coke between and separating each charge, iron to iron is charged. This has the same effect as charging too much iron down one side of the cupola.

Melting Large Lumps.

With regard to heavy lumps of scrap, it is interesting to note that the author has melted lumps of scrap weighing from 10 to 14 cwt. successfully, that is, without lowering the temperature or showing any signs of chambering; but the following precautions have always been taken, namely, waited until the afternoon's blow when the furnace has been at its hottest; given an extra quantity of coke; placed the lump of scrap as near the centre of the cupola as possible, and placed 4 to 5 cwt. of light scrap around and on top of it. The object of placing this light scrap around the heavy scrap is to get it to assist in the melting of the heavy lump. Owing to its thinner section it will melt much quicker, and as the molten metal runs around and over the lump it will assist in its melting. If the above precautions are not taken it is probable that the heavy lump of scrap will wear away ¼ the bed coke and cause chambering.

Precautions Necessary to Prevent Chambering.

Having stated some of the causes of chambering, it will be as well to state what steps are necessary to be taken to remove it. An observant furnaceman can soon tell whether his furnace is working properly or not, and if not, if he is *au fait* with his work, will at once take steps to remedy the fault. First considering heavy charging, the first metal tapped may be rather lower in temperature, and the third charge tapped, owing to the lowering of the coke bed, will be still lower in temperature. The efficient furnace-man will know that there is something wrong, either that sufficient coke has not been charged, or that the charges of iron are too heavy, and he will at once take steps to remedy this by giving more coke to raise the bed to its proper height and reduce the weight of his charge. But it might be that before this extra coke and reduction of charges can take effect, that the coke bed is so lowered that the chambering has already commenced. In such a case, the only remedy is to stop-off the top row of tuyeres and prevent the cold blast from blowing on to the iron and melt with the bottom row of tuyeres only. This, of course, will lower the melting zone and retard the melting a little, but the hot gases rising from the new melting zone will have the effect of melting away the iron that has gathered about the top tuyeres. The melting must be continued with the bottom row of tuyeres, until the extra coke has reached the original melting zone and then the stoppers may be moved from the top tuyeres and normal blowing resumed.

XUM

Overcoming Difficulties.

When chambering has commenced through too much metal being charged down the side of the furnace or charging metal to metal, or by heavy lumps of scrap, it may be detected and remedied by taking the following steps. The furnace-man should make an inspection every now and then to see that his cupola is working properly. This he is enabled to do by looking through the peep-holes that are placed in the centre of each tuyere lid. If on looking through these he finds that the coke at the end of the tuyeres pipes is burning brightly he knows that the furnace is working satisfactorily. But sometimes he will not be able to see into the cupola through one or more of these tuyeres; the coke instead of burning brightly is a dense dark mass.

This may not be serious, as it may only be caused by some of the slag dropping upon the coke and becoming chilled by the cold blast. On the other hand, it may be caused by chilled iron and slag. If the former it can easily be removed by inserting an iron bar through the tuyere pipe and poking it away. In this case after removing the obstruction another piece of coke will descend from the coke bed and take its place. If the latter is the cause then it will be more difficult to be removed, and if after its removal more coke does not come down to take its place, then the furnace-man should know that there is some obstruction above the tuyere that is preventing the descent of the coke. Steps should be at once taken to remove the obstruction; this can only be done by at once stopping off the tuyere or tuyeres and preventing the cold blast from entering the cupola, and by charging extra coke down that side of the cupola where the chambering has taken place. By the time the extra coke has reached the melting zone the obstruction will have been mlted away by the hot gases generated by the lower tuyeres. All this only applies to cupolas that are provided with a double or more rows of tuyeres. If there is only one row of tuyeres and chambering has commenced it is highly improbable that the obstruction can be burned away by stopping off the tuyere, as there is not sufficient heat generated below the tuyeres to melt the iron away.

Scaffolding.

Another source of trouble in cupola practice is the scaffolding of charges. This may be caused either by the bad condition of the lining, or charging pieces of pig-iron or scrap that are too long, and becoming wedged against the sides of the cupola, thus holding up the charges above. If the scaffolding takes place near the charging door it may be liberated by poking at it with an iron bar, but if it takes place some distance down the cupola and it cannot be got at with a bar the best plan is to stop blowing for a time. Then as the furnace cools down the metal will contract a little and thus liberate the scaffold. Another reason for stopping the blast is that, if blowing was continued for some time the coke that was put on to melt the charge would probably be burned away before the scaffolding was liberated, and the consequence would be dull iron. Extra coke should always be charged when scaffolding takes place, and the charges are held up for any length of time, as it is almost certain that some of the coke will have burned away and it will require this extra coke to raise the bed to its proper level.

Most furnace men will have experienced a difficulty from time to time in running off the slag. This may be due to an insufficient supply of limestone, or a tuyere placed too near the slag notch, or it may be caused by a leakage between the brickwork lining, allowing the blast to blow upon the slag as it leaves the slag notch. If it is due to lack of limestone the slag will be a thick pasty mass, and only continual poking with a bar up the slag hole will allow the slag to run. If a tuyere is placed too near the slag hole the cold blast will blow upon the slag and lower its fluidity, and in time, owing to its chilling effect, stop it from running out. An indication of slag being chilled by the blast is the presence of slag wool floating about the slag hole. When this appears it is advisable to stop off the tuyere nearest the slag hole. If this does not arrest the making of slag wool or allow the slag to run off freely, it is probable that the slag is chilled by a leakage between the bricks above the slag notch. Then the only action to take is to cut away the chilled slag and with a flat bar place some ganister on top of the slag notch and stop the leakage. Some furnace men will continue blowing until the slag is cut away from the slag hole, the time taken to do this may be 30 minutes or even longer, depending on its extent. In the meantime the slag is accumulating in the furnace, and this cannot but be a detriment to the quality of the iron, because the molten metal as it drops from the melting zone will have to pass through a thick layer of slag, which will not only lower its temperature, but the metal will take up some of the oxides from the slag and probably cause wasters.

Slags.

The temperature at which the metal is melted is closely associated with the composition of the slag, as is also the condition of the iron charged.

If a rusty or oxidised iron is charged into the cupola the result is a black slag caused by an excess of oxide of iron. If the melting zone is not kept up to its proper height the metal will become oxidised and give the same effect.

Table I.—*Composition and Colour of Cupola Slags.*

No. 1.	No. 2.	No. 3.
SiO_2 53.00	45.00	50.80
Fe_2O_3 23.40 ...	17.92	16.00
Al_2O_3 1.60	8.08	8.20
MnO 12.00	13.00	14.80
CaO 10.00	16.00	10.20
Stoney Greyish Black.	Dark Olive Green.	Light Brownish Green.

The colour of the slag is a guide to its composition, as is shown in Table I. In the case of No. 1 the stoney black appearance is caused by an excess of iron, along with a fair quantity of lime and only a small amount of alumina.

No. 2.—The colour of this is due to the lower percentage of oxide of iron, and to an increase in the MnO and alumina.

No. 3.—The colour of this is due to a further reduction of oxide of iron and an increase in the percentage of MnO and alumina.

Shape of Cupola.

Another cause of bad melting is due to the cupola becoming out of shape. When a furnace is newly lined it should be as nearly circular as possible, and it is part of the furnace dresser's duty to see that it is kept so. But sometimes, probably due to a low blast pressure or an obstruction in front of the tuyeres, the blast will hug the sides of the furnace; when this happens the lining is quickly scoured away. Now if the furnace dresser should neglect to build this up to its original size, or at least in a line with the other brickwork, then during the following blow more of the lining will be burned away, and a cavity will be formed. Heat, like anything else, will follow the line of least resistance, therefore instead of the charges getting the full benefit of the heat generated, a large amount of it will be wasted by it passing up that side of the furnace which offers least resistance. Some years ago trouble was experienced with a cupola. The iron could not be melted either sufficiently hot or fast, and at the end of the blow the furnace, in the region of the melting zone, was practically choked with iron and slag. The furnace man blamed the chargers, of course, so the author spent a whole day on top of the stage and saw that the charges of iron and coke were evenly distributed, but the result was the same. The next day after the cupola had been chipped out an inspection was made of the cupola, and it was found that the lining from the top tuyeres to about a foot above the melting zone had burned away to a depth of 6 or 8 ins., and that the furnace instead of being circular was egg shaped. The result of this was, that when blowing down with an insufficient stock in the cupola to confine the heat, only a portion of the last two or three charges were melted, the remainder being stuck to the side of the cupola in a pasty condition. Before using the cupola again the brickwork was rounded off, and no further difficulty was experienced.

Tuyeres Must Not Project.

Another fault that is likely to upset the chemical calculations of the mixture is caused by allowing the lower part of the tuyeres to project into the furnace. Anyone who has looked through the peep-hole of a tuyere will have noticed that the molten metal falls from the melting zone like

drops of rain. Some of these fall on the projection and are immediately chilled by the cold blast. As the molten metal continues to drop on the projection the outlet of the tuyeres is gradually closed and the pressure of air is increased, if the same volume is delivered, which is the case where a positive blower is used. The effect of this is to Bessemerise the iron, *id. est.*, owing to the increased velocity of the blast due to the closing up of the tuyeres, the air passes through the molten metal as it drops by the tuyeres, and oxidises the various elements in the metal, especially the silicon. The result of this is that although a mixture of iron has been charged to give a certain analysis after the allowances have been made for ordinary losses and gains in melting, a different result will be obtained. It may be that the chemist has calculated his mixture to give a silicon content of 1.5 per cent. at the cupola spout, but owing to excessive oxidation, due to the increased blast pressure, a silicon content of 1.2 per cent. is obtained, which will account for the complaints from the machine shop about castings being hard to machine.

New Railway Rates for Iron and Steel.

The Rates Advisory Committee of the Ministry of Transport commenced the consideration on Tuesday, March 28, of the proposals of the railway companies with regard to the new classification of goods by merchandise trains in relation to iron and steel, engineering, etc. Sir Francis Gore-Brown, K.C., is the chairman of the Committee, and six days in all have been allocated for this part of the inquiry, viz., Tuesday, Wednesday and Thursday of this week and next week. The position is that the old railway classification of A, B and C classes has been replaced by a new classification of some 20 classes, the rate getting larger as the class number progresses, apart from the question of exceptional rates.

The National Federation of Iron and Steel Manufacturers were the opponents at the meeting on Tuesday, being represented by Mr. M. F. Barnard, the transport officer of the Federation, and Mr. Harold Rose. At the same time, as will be seen, various members of the Federation took charge of particular objections.

Pig-iron.

Mr. M. F. Barnard asked that pig-iron should be reduced from Class 5 to Class 3, railway company's wagons. There was no provision for owners' wagons, and he did not believe the railway companies would agree to such a proposal; the Federation would welcome the opportunity of being able to use owners' wagons. At present exceptional rates were allowed for pig-iron, and on an average the rate was from 18 to 20 per cent. below the Class B rates; in some cases it was 30 and 40 per cent. below. He asked for Class 3 because it was felt that Class 5 would not absorb the exceptional rates. Class 3 rates were expected to be about 5 or 7 per cent above Class A rates at present. As to the value, in 1892, the value of pig-iron was 38s. 5d. per ton; the immediate pre-war value was 51s. and the present value from 75s to 90s. The railway companies carried from 6 to 7 tons of material for the manufacture of the finished product, in the shape of coke, coal, etc., and then got the carriage on the finished article, of which the pig-iron formed part. Last year the total output of pig-iron was 8 million tons, and if the iron and steel industry was to compete in the world's markets it would only be able to do so by having cheaper railway rates here. At present 20 per cent. of the selling price was absorbed in railway charges, and the traffic should be put in the lowest possible category.

Mr. Pike, for the railway companies, said there were many other articles in Class 5 of a lower value than pig-iron and it was felt that Class 5 was a reasonable place to put it.

Mr. Barnard emphasised the point of the large consignments in which pig-iron was sent, and that it occupied a space of from 5 to 7 cub. ft. per ton against 25 cub. ft. in the case of limestone.

The Committee, however, accepted the railway companies' classification.

Scrap.

Mr. Barnard said he was also going to ask the same thing in the case of scrap, but having regard to the decision in the case of pig-iron, he felt it would be useless. He did, however, ask that 4-ton lots should go in Class 5. At present that was a 6-ton class.

Mr. Pike said the railway companies wished to encourage the trade to send bigger lots. He agreed, however, to the minimum load being 4 tons in the case of Class 5.

Agreed Decisions.

We append details of a settlement arrived at between the Classification Sub-Committee of the Transport Committee of the National Federation of Iron and Steel Manufacturers and the Railway Companies on the question of the revision of general railway classification of goods by merchandise trains which affect foundries:—

As Modified by Negotiation.

	Class.
Axle-box guides, iron or steel, in the rough, for locomotives	7
Axle boxes, railway, iron or steel, in the rough	7
Bolts and nuts, iron or steel	8
Boxes, charging, iron or steel, for furnaces	7
Brackets, hangers, pedestals, plummer blocks, standards or wall boxes for carrying shafting, without bushes or bearings of any kind—	
Brackets, wall, iron or steel (as castings)	10
Electric tramway poles (street) and pole fittings (not ornamental), iron or steel	7
Horn blocks, iron or steel, in the rough, for locomotives	7
Pedestals, bundles of, rough, unfinished, for pit corves—(castings)	8
Retorts, retort lids, retort mouthpieces and retort levers, iron or steel—	
In the rough	7
Not in the rough	9
Stands, iron or steel (rough castings), for annealing pans	8
Buffers (railway), heads, rods and sockets, iron or steel—	
For wagons	7
For locomotives and carriages—	
In the rough	7
E.O.H.P.	11

Additions.

	Class.
Castings, not machined, E.O.H.P.—	
Iron or steel, undamageable, for engine or machine construction, straight from the mould, or with the skin removed to reveal any defects	8
Iron or steel, undamageable, for engine or machine construction, rough, but with flat parts machined for bolting to other parts	9
Malleable iron, E.O.H.P.	10
Pipes, iron or steel, for gas or water mains	7
Trough, galvanising, iron or steel	10

A New System in Moulding Boxes.*

The author states that the cost of castings depends greatly on the cost of manufacture and maintenance of moulding-boxes, and the foundryman's chief problem is so to design the latter that they will comply most fully with the following desiderata: (1) Easy adaptability to most patterns, thus saving moulders' labour, material, and thought; (2) great rigidity and low weight, so that crane labour can be saved on all but heavy castings (all foundry cranes are overworked, so this leads to smoother running); (3) speedy assembly—easy to knock out, easy to fit with stays, and no complicated bottoms; (4) the minimum of floor and store space required; (5) the design should allow variety by rearrangement of parts. If these conditions are secured, new work can be quickly proceeded with and general costs are saved.

Boxes which proved to be somewhat deficient as regards (2) and (3) were designed by Malzacher as early as 1912; since then he and Zach have continued with the problem and have achieved some success. The box particularly described has separate ends and sides, and these are secured by a pin and two wedges, of opposed bevel, at each joint. This is stated to be preferable to bolting, as only a hammer is required, and rust is negligible; moreover, upkeep is much less costly. While this design can be quickly taken down, it is rigid and has never come adrift itself, even on the jolting machine. A system of slots and wedge-ways on the sides allows stays or flats to be fitted in the box parts at will. These boxes have proved very satisfactory in sizes from 16 in. square to 80 in. square. A table shows the extent to which these and other more common types of one-piece and built-up boxes fulfil the conditions set out at the beginning. Kothny. ("Giess. Zeit." 18, 265-268.)

* Institute of Civil Engineers (Abstract).

Brass Foundry "Imp—ology." *

By D. White.

The ancient writer, in dealing with evil, gives to it a personality, setting it up as something which is antagonistic to good, speaking of it as belonging to a certain kingdom and of its being possessed of great power, which it continually exercises in the frustration of all that is progressive and for the good of mankind. Finally he gives it the character of a wrestler, with which all true progress must engage.

Now across the path of every progressive foundryman there stands a host of opposing forces or evils, which may be called "Foundry Imps," in order that character might be given to them.

The Birth of the Imps.

The advent of the "Imps" can be imagined to be as follows:—

Many centuries ago, two imps (there must have been two on account of the numbers that have been here ever since) were cast out of the inferno on account of their wickedness.

These "Imps," finding themselves homeless, began to look for a suitable place where they might set up a colony.

Passing an iron foundry one day at casting time (Messrs. "Tubal-Cain & Company") Imphenous suggested to Imphenia that this would make an ideal squatting place, as it certainly resembled the old home more than anything he had seen since they left there, and as the people would have no means of catching them, they should be able to live comfortably and carry on their destructive work for many years.

So together they entered their fresh abode.

For a long period things went on very well, but as the number of the imps increased, fresh fields had to be sought for their exploits.

About this time a firm trading under the name of "Aeron & Company," casters of Precious Metals and other Nonferrous Alloys, came into prominence. The imps, after discussing the matter, decided to invade the Nonferrous Foundry also, and carry on their campaign of destruction there too.

The Creation of the Imp Army.

This deliberation was carried out with great success by the "Imp Army," and for many centuries they held the sway in every nonferrous foundry on earth, and to-day, in spite of modern science, they are as vehement in their attacks as ever.

One of the most vicious of the imp family is "Imp Oxygen," as quite 50 per cent. of the brass foundryman's troubles emanate from this small youth.

Like most other things and beings, this Imp is all right when in his proper place, and from a health point of view we gladly welcome him as a diluting agent into the thick atmosphere of our foundries—that is, of course, when he does not come in "draught" formation. Not only does he sustain life, but he is also the main support of combustion.

The nitrogenous chariot in which he rides is four times his own weight, and when this vehicle has brought him into contact with the red-hot coke of the furnace he alights and joins affinity with the carbon of the coke—dismissing his chariot of nitrogen, which passes, apparently unaltered, through the hot furnace to the atmosphere above.

The result of the "Imps'" association with carbon is that things become hot, this union being attended by something like 8,000 calories of heat; that is if the carbon is burned to carbon dioxide. In this capacity as a sustainer of combustion we again welcome him.

Now this little imp has an affinity for most created things; in fact, it is estimated that one half of the earth's crust is made up of the small chap, the other half consisting of materials with which he is associated, such as sand, rocks, iron, etc.

His affinity for copper is very marked, which, when in a hot viscous state, seems to bend to his overtures and receive him into its very heart. It is here that the subtility of this imp is manifested. He arrives in thousands at the bottom of the furnace to accomplish the work of reducing the solid copper to the molten state, and at the same time thousands more are in waiting in the upper regions of the furnace ready to attack the metal when the right temperature has been reached.

Results of the Attack.

Striking evidence of the effects of this union are to be found now as in all ages, in the worried countenances and lean banking accounts of many brass foundrymen.

It cannot be hoped in one short article to deal with all the disastrous results which are the outcome of a simple flirtation on the part of copper with this wicked little imp; yet the limited space at our disposal might be used in dealing with some points which, although common knowledge to many, may be that one thing lacking in the experience of some.

Once copper has embraced this wily imp there is produced a greater amount of gangerine, or Cu_2O inclusions in the metal than one would at first credit.

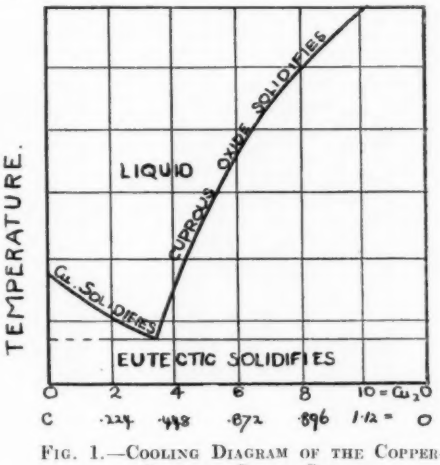


Fig. 1.—Cooling Diagram of the Copper-Cuprous Oxide System.

Fig. 1 shows the amount of Cu_2O (often referred to as dirt) produced by varying amounts of oxygen absorbed by the copper. The diagram shows that when molten copper containing less than 0.38 per cent. oxygen solidifies, copper crystallises out first, and later in between the copper crystals there solidifies a eutectic of copper and cuprous oxide. This eutectic contains about 3.45 per cent. of Cu_2O, equivalent to 0.38 per cent. oxygen.

When oxygen exists in copper above the eutectic proportion 0.38 per cent. oxygen, Cu_2O comes out first until the eutectic concentration is reached, when the mass solidifies. A glance at the concentration axis will explain the relation of oxygen to copper.

Now as the atomic weight of copper is 63, and that of oxygen is 16, it will be noted that for every part by weight of oxygen absorbed by the copper, or for every imp the copper embraces, nine times its own weight of Cu_2O is produced. Whilst the oxygen existing as oxide eutectic is in the proportion of 30 to 1.

The influence of this imp upon all metals is more or less disastrous His union with tin forms hard crystals which can be crushed to powder; this gives rise to dirt and planes of weakness in the resultant alloys. Oxide of zinc, which is sometimes troublesome, is another of his products. These tenacious films, which tend to cause dross and cleavage planes in aluminium and manganese bronze alloys, is just another of this imp's sidelines.

Very often castings which machine up perfectly, and are apparently without flaw, fail miserably when under steam or hydraulic tests. Oxide of copper interspersed throughout the mass is mainly responsible for this evil. Castings which do not require machining, but have to give certain

* A Paper read before the Birmingham Branch of the Institution of British Foundrymen.

mechanical tests, often fail from the same reason; that is, Cu_2O inclusions.

Fig. 2 shows a micro-section of a copper bar after rolling; no doubt the annealing and working of the bar has given to the Cu_2O this peculiar formation. In cast-copper it appears in patches and a network of streaks, which weaken the metal in proportion to the amount of Cu_2O present in the charge. A good example of how the imp appears in gunmetal is shown in Fig. 4, reproduced from the work of Carpenter and Elam, and shows the weakening effect of Cu_2O in gunmetal castings. Fig. 3 shows a microphotograph of part of an ingot of commercial copper; here the "imps'" presence is again manifest.

The brass foundryman dealing with high-tension bronze should be thoroughly acquainted with the different brands of copper on the market, as it is possible in dealing with bronze of this type to drop two to three tons tensile, and 5 per cent. of the required elongation, through using a wrong brand.

In the foregoing remarks the possibility of Cu_2O inclusion in castings, caused by ceaseless efforts of "imp oxygen" in his attempts to bar the foundryman's way to progress, has been taken into consideration.

Gas Holes in Castings.

As the trail of the "imp" is followed, it is found that he proves himself to be very adaptable, possessing a perfect knowledge of the likes and dislikes of metals. He knows as well as any metallurgist that most metals have the power of dissolving gases, and in order that the foundryman's hours of sleep might be curtailed and his banking account still further depleted, he joins affinity with any stray imp of carbon in the neighbourhood of the furnace, and in the form of CO (carbon monoxide) presents himself to the molten charge for acceptance.

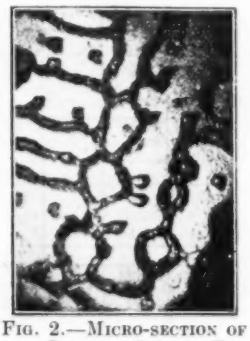


Fig. 2.—Micro-section of a Rolled Copper Bar showing the Effect of Oxygen.

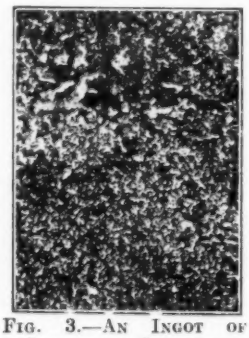


Fig. 3.—An Ingot of Commercial Copper contaminated with Oxygen.

Fig. 4.—A Micro-section showing the Weakening Effect of Oxygen in Gunmetal.

The charge of metal inside the crucible might be able to deny him an entrance, were it not for the "warm embrace" of the imp's friends outside, which finally succeed in bringing the charge into such a condition that it willingly becomes associated with this importunate little imp. As soon as he has gained admission he makes his presence known by expanding himself at a ratio of 1-273 part of his volume for every degree Centigrade added to the metal by his relatives operating on the outside of the crucible. When a certain temperature is reached, he mysteriously goes into solution and remains dissolved until such time as the castings are poured and the metal, through loss of heat, seeks to regain its stable form. As the temperature drops the metal seems to become conscious of the "imps'" presence, and in order to redeem its good name, which during its period of "softness" it had woefully lost, it seeks to expel from its mass this treacherous villain who is seeking to spoil its usefulness as a metal.

The expulsion of the "imp" can only be partially accomplished on account of the film of metal which has formed against the sides of the mould, behind which we often find masses of small cavities, which represent the volume occupied by the imps at the freezing temperature of the mass.

The Sulphur Imp.

It is not suggested that all gas holes in castings are the outcome of this "imp's" union with carbon as CO; for when sulphur is present in the gases of the furnace, one sulphur imp joins hands with two imps of oxygen, and as sulphur dioxide (SO_2) they are absorbed by the metal, and like CO, go into solution, only to be thrown out as the temperature of the mass is lowered.

The effect of sulphur upon copper-base alloys may be far more deleterious than is admitted by some authorities.

When we consider the nature of the ore from which above 80 per cent. of the world's supply of copper is extracted, namely, the "sulphide ores," with an average sulphur content of 35 per cent., the enormous affinity copper possesses for this impurity will at once become clear. Seeing, then, that those two elements are so closely linked together in nature, surely it is within the bounds of reason to suppose that molten copper will seek the companionship of the "sulphur imp" if brought within its reach.

A fundamental principle known to all smelters of copper ore would seem to bear out the above statement. The principle is, that in melting down a charge of copper sulphide ore, the copper has first claim on any sulphur present, and not until it is saturated does it allow the sulphur to associate itself with any other impurities in the ore.

Now the fact that manganese also possesses a great affinity for the "sulphur imp" is well known to many iron and steel foundrymen.

Manganese bronze may contain from 30 to 40 per cent. of zinc, and therefore should be thoroughly de-oxidised, seeing that from 1½ to 2 per cent. of zinc, if properly used, is sufficient to de-oxidise copper. Yet it is generally accepted that the addition of manganese to this alloy is for the purpose of de-oxidisation, and that it is on this account that the metal exhibits such valuable properties.

The above facts, coupled with observations which are outside the scope of this paper, have led the author to suggest that the chief value accruing from the addition of manganese to so-called manganese bronze is not so much de-oxidisation as de-sulphurisation.

An experiment was made with three small ingots cast from an ingot of commercial copper. No. 1 was cast after being melted under a cover of charcoal; this showed a state of excessive oxidisation. No. 2 was melted with the addition of 0.5 per cent. of 30 per cent. manganese copper; the condition was only very slightly altered. To ingot No. 3 was added 0.5 per cent. of 15 per cent. phosphor copper; the appearance of this ingot, as well as the fracture of the metal, was all that could be desired.

It would be interesting to know if the research workers have followed the trail of the "sulphur imp" to its lair; that is, in connection with copper-base alloys. Nature would suggest that beyond the crystal boundary, in the close embrace of the copper itself, this imp finds a resting place, and there, in chemical combination with copper, a family is produced bearing the name of "copper sulphide." It is therefore reasonable to suggest that the diseases from which copper-base alloys suffer, of which season cracking is one, may find their genesis in the reunion of copper and sulphur.

The Hydrogen Imp.

Hydrogen, under certain circumstances, is always present in the gases in the furnace, and may be greatly augmented if the coke should contain an

abnormal quantity of moisture, as this gives rise to the formation of hydrocarbons.

It also associates itself with sulphur, producing a very troublesome gas named hydrogen sulphide. This gas is said to be responsible for 15 to 20 per cent. of the gas holes in gunmetal and most non-ferrous castings. Fig. 5 gives some indication of the damage these imps are capable of doing. This is not an uncommon sight in foundries where a "strangle hold" is not kept on the "imp army."

The Battleground.

The battleground on which 50 per cent. of the success or failure of the brass foundry is decided is the furnace room. The office may be equipped with the finest cost-keeping system extant, and yet find smooth running very difficult on account of the replace work, part machines, etc., which certainly follows in the trail of bad melting practice. There is more true economy in stocking a dozen crucible rings and covers than in providing an overstock of office furniture.

Having noted the character of these imps and their methods of attack, also the battleground on which they seek to arrest progress, the foundryman, if wise, will seek to instruct his furnaceman, not only to bring metal to a fluid state, but also to become conscious of his unseen enemies "the imps," who, though unseen, are nevertheless real. The conservation or holding back of knowledge of this character from the intelligent furnaceman is a ruinous policy, and one which has greatly hampered foundry progress.

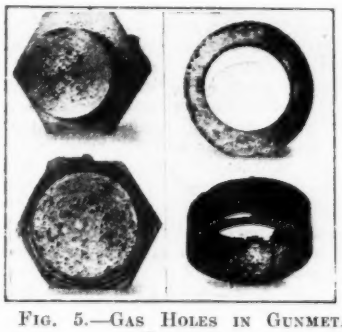


Fig. 5.—Gas Holes in Gunmetal Castings.

By a simple object lesson a foreman may teach his furnaceman more in ten minutes than if left to himself he would learn in ten years.

To many furnacemen, oxide of copper is but a name, whilst hundreds of others have never even heard of it, although they may be mainly responsible for its production every day.

If the foreman will get his furnaceman to put a piece of sheet copper scrap or rod in the furnace, and when it has reached a red heat, withdraw it and allow it to cool down on a plate so that the oxide of copper formed can be gathered up and inspected by the furnaceman, who should be told that the material which resembles dirt is responsible for many of the gas holes and Cu_2O inclusions in castings. By this simple lesson he will understand one of the characteristics of the enemy, and thus he will be the better able to shield the metal from his subtle attacks.

The management should see that he is encouraged to do this, by keeping the tools in the foundry furnace room in good repair.

He should also be provided with a suitable flux or covering for the metal—charcoal, borax, and common salt in equal quantities is a very effective protecting medium. It is better to spend 10s. in putting the root of the matter right than to wait until the harvest and lose £20 through the production of bad fruit.

There should also be kept in a dry place a supply of 10 or 15 per cent. phosphor copper. It is a good practice to always use about 0.5 per cent. of the material in dealing with gunmetals of a low zinc content.

Coke for the furnaces should be of the highest calorific value, and should be broken in suitable pieces. This remark may seem superfluous, but the difference between good and bad metal has often been traced to bad firing, caused by the uneven condition of the coke. It is important that a charge of copper should be melted with the first charge of coke if at all possible, and for this reason it is better to have the furnaces a little too large rather than too small.

The Trail Hunter.

It may be interesting to recount the story of the old master-foundryman who was in difficulties over some 99 per cent. copper casting which weighed about 150 lbs. The castings as produced were useless, the metal being full of small holes

He determined to find out the cause of these defects, and started out on the following trail:—First he examined the mould, which he concluded was by far too dense. A mould was then made according to his own instructions, which, he declared, would put the matter right. The result was no change in the condition of the castings. The trail then led him to the coremaker, whom he upraided for making hard cores, and not using sufficient manure. This second attempt resulted in failure also. The coremaker was again visited, and asked to show him the manure he was using, which resulted in the horse being blamed. The root of the difficulty was in the furnace-room, where the copper had been carelessly melted, and the addition of the 1½ per cent. of 15 per cent. phosphor-copper made whilst the crucible was in the furnace and the metal at too high a temperature. When the pot was drawn and skimmed off, immediately there formed a skin of oxide on the top of the metal on account of the phosphorus having passed off as a copper phosphide or slag. When this film appeared it was taken as an indication that the metal was ready for pouring, and of course this procedure resulted in the production of bad work.

The method adopted by the foreman was to melt carefully the copper under a cover of charcoal, and when raised to a sufficient heat, withdraw and allow it to stand without skimming until the casting temperature was reached. This temperature was ascertained by the application of an iron rod to the metal, no pyrometer being available. At the right moment the charcoal covering was skimmed off, the deoxidiser applied, the metal stirred and the mould cast. The result was good castings.

Human Element.

The "imps" encountered in the foundry proper are not so much associated with materials as with human nature itself; in fact they are often referred to as the "human element."

The most important of these is "imp carelessness," who is notorious for his untiring efforts amongst apprentices. He knows that if he can successfully form the character of the lad according to his own law, which may be summed up in two words "near enough," he has succeeded in putting a barrier in the way of improving the standard of castings; for a careless apprentice is a careless journeyman in the making.

The first fruits of his work are seen in the trimming shop. Here from 25 to 100 per cent. more time is required to deal with his work than with castings of a reasonable standard of perfection. Besides the time element there is to be considered the waste in metal caused by chipping, filing, and grinding, also the tools used in these operations. Following this there comes from the machine shop complaints that it is almost impossible to set these castings up true on account of their distorted condition.

Gating.

In dealing with small work, much trouble arises out of the careless selection of suitable downgates. The author prefers small downgates with ingates of a sufficient area, not only to run the casting, but to insure that it is fed whilst setting. This demands that the metal be cast at a slighly higher temperature; a practice which produces better results than when dull metal is used.

In making gun-metal castings for high-pressure work it is very important that height be given to the runner. When this class of work is of a heavy character, reaching a thickness of 2 in. or more, it is the usual practice in many foundries to chill the heavy parts of the castings, and also to feed the large risers with rods. Experience caused the author to abandon the use of both chills and feeding rods in connection with gun-metal work, except in very exceptional cases.

Twelve castings were ordered, weighing 5 cwts. each, which had to withstand a hydraulic test of

4,000 lbs. per square inch. The first one cast was chilled in all the heavy parts, and the risers were fed with rods until they set. The other eleven were cast without chills and were not fed in the manner described above, but an additional height of head was allowed. The only casting that leaked was the one which was chilled and fed, the leaking taking place where the risers had been.

This condition of weakness is just what one might expect to find in the metal after such treatment, and is caused by the agitation of the metal with the feeding rod, as the cooling mass passes through its range of freezing temperatures.

An example of the care required in the application of runners is shown in Fig. 6. This represents a short Admiralty gun-metal liner, which turned up spongy along the dotted line as shown. The casting was said to be suffering from all the diseases a scrap casting could possibly have; when the responsible man, after a close examination of the casting, concluded that the fault lay in the fact that only one downgate had been used, and that the flow of metal had been stronger at the runner side than at the side opposite, and as a consequence an over-lapping took place, resulting in the entrapping of the film which should have risen into the head provided for it. An additional

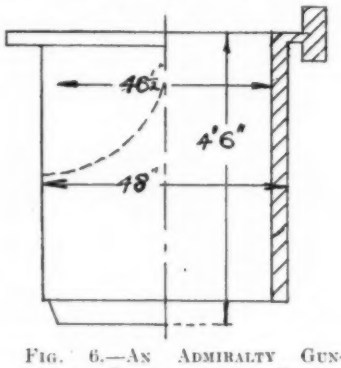


Fig. 6.—An Admiralty Gun-metal Liner, showing Sponginess along the Dotted Line due to Faulty Gating.

gate put at the other side effected a cure. The position of runners is a detail over which the "careless imp" should have no control.

Sand Selection.

Very often evidences of this imp's work are seen in the buying department. A consignment of sand arrives, the texture and bonding power of which renders it almost useless for a particular class of work. But the buyer has been persuaded by the vendor to order it, because it is cheap, and a neighbouring foundry is using it successfully. When at last the trouble cloud bursts, resulting in the loss of castings and capital, and the jeopardising of the firm's reputation, enquiries are made which reveal the fact that the other foundry is making castings principally in dry sand, for which the sand supplied is admirably suited.

Some time ago the author pointed out that 50 per cent. of the iron foundryman's trouble vanished when he mastered the cupola, and another 25 per cent. followed when he thoroughly understood the nature of the sand he was using. The same holds good in the brass foundry.

The refractoriness of sand is of great importance, and, of course, as its composition directly affects this property, it is necessary to keep as low as possible and fluxing agencies, such as alkalis, iron oxide, lime, and magnesia, as these elements greatly impair this property and produce rough castings.

The difference between the firm who is producing metal castings of an excellent quality and the firm which is not, is that the former has control of the "imps," while the latter, although unconscious of the fact, is being controlled by them.

AMERICAN FOUNDRYMEN'S ASSOCIATION.—Amongst the Europeans who are contributing Papers at the Rochester Convention are Messrs. F. J. Cook, of Birmingham; E. Ronceray, of Paris; J. Leonard, of Liège; and T. Levoz, of France.

Plaster of Paris in Engine Pattern-Shops.

By J. Drinkwater.

There are many plaster patternmakers who think that it is because of unreasoning prejudice that plaster is not more used in engineering pattern-shops. The two branches of the craft have always been kept so distinct that they have really developed as separate trades, although the underlying principles are the same in both, and, while admitting the value of specialisation, there seems no proper reason why a patternmaker should not be able to adapt himself to either plaster or timber work. It is not proposed to discuss the relationship of the two sections here, however, but to discuss briefly whether an extension of plaster patternmaking to ordinary engineering work is advisable or profitable.

The fundamental difference between the light casting trade and ordinary engineering is that for grates, rain-water pipes, gutters, etc., the eye, within limits, is of greater importance than the dimension. In the construction of a pattern for any part of moving mechanism, accuracy is more important than the appearance. When making plaster patterns strickles and boards are very largely used, and for irregular shapes the hands. It is, of course, possible to pare the plaster, using a template as a guide, but there are limits to this. In the engineers' pattern-shop the pattern of irregular shape is the rule rather than the exception, and in many cases it is exceedingly difficult to visualise the finished pattern and core-box after examining the blue print. It is because plaster cannot possibly be used in constructing the general run of engineers' patterns that it is not used for any. But in almost all pattern-shops there are jobs, circular and otherwise, which could be run up in plaster much cheaper than they could be built and turned in wood and give equally good results in the foundry.

In shipyard pattern-shops many jobs have to be done which approximate closely to what are called light castings, and in all repair shops plaster could be used much more than it is. It is quite common, for instance, for a patch to be fitted over a crack or other flaw in a condenser or cylinder. The making of the pattern is rather a tedious task. The patch is made sufficiently large to enable it to be fastened by means of studs or screws, on the casting, at a reasonable distance from the crack; it may be cast in gunmetal or ordinary brass, and should be about ¼ in. thick. In designing the patch a good deal is usually left to the patternmaker. The *modus operandi* is usually as follows:—A block of wood free from knots is bedded on the casting, chalk or red lead being freely used, after which the required thickness is gauged round the edge. As the patch may be fitting into a large fillet or round a corner callipers are used to test the thickness. To prevent it from warping, the patch is usually painted and varnished before going into the foundry. It is not always possible or convenient to make such patch patterns with plaster of Paris, but the writer has seen it done successfully.

Another use for plaster of Paris in general shops is for the repair of old patterns and for working up large fillets. The writer has also seen it used successfully for making bends. For heavy engine or machine work, however, plaster does not appear to be very useful, and for many other jobs where it could be used it is probably quicker and on the whole cheaper to make a skeleton pattern.

IRON FOR HEATING-FURNACE CASTINGS.—Mr. Y. A. Dyer, writing in the "Iron Age," recommends the following analyses to withstand alternate heating and cooling to which domestic furnaces are subjected:—

Percentage of	Heavy.	Medium.	Light.
Silicon	1.75	2.00	2.25
Sulphur	0.08	0.06	0.06
Phosphorus	0.30	0.40	0.50
Manganese	0.99	0.70	0.60

Repairs in the Melting Furnace.

How to prolong the life of the furnace lining is a proposition which is always before the responsible management. A heat or two more or less out of a lining may make all the difference on the profit and loss account. At the outset it will be admitted that the firebrick is less affected by heat than by the influence of acids, whilst the very best firebrick will corrode because it lacks the required resistance against the oxides. A truly fireproof material must of course not only resist high temperature, but basic slag, alkaline vapours, and fusible alkalies. Its fire resistance depends as much upon its chemical composition as on the substance of its component parts, *i.e.*, basic and acid components must stand in proper proportion to fire resistance and durability. But such material, particularly where it is required for patching, must in addition possess plasticity, binding properties, and solidity, conditions which are only possible with material which is free from iron and chalk, and at the same time rich in clay alloy (Kaolin), whilst, of course, the material should also be of a constant known quality.

Messrs. E. Capper Robson & Company, Limited, 1, North Road, Darlington, Co. Durham, have recently acquired the sole selling rights for the United Kingdom of a material which appears to meet in a very marked degree the requirements set out above. It is known as "Cupoline," and has been extensively employed on the Continent for some years. It is in point of fact a mineral used as mined, without any intermediate manufacturing process. The purity and suitability of its composition are evidenced by the analysis, which is as follows:—SiO_2 = 88.4 per cent.; Fe_2O_3 = 3.6 per cent.; Al_2O_3 = 6.2 per cent.; CaO = nil; MgO = 0.054 per cent.; Na_2O_2 = trace; K_2O = trace; loss in ignition, 2 per cent.

Unlike so many refractories which require the addition of a foreign binder to render them serviceable, the binders generally having a lower refractory value than the base, the refractory value of the material is of course the lowest melting point of any of its components. Cupoline is complete with its binder in the form of alumina and has a melting point of 1,850 deg. C.

So much for the theoretical side. Our representative, however, was able to ascertain the value of the material and its behaviour under actual everyday working conditions.

The Darlington Forge, Limited, have for some time been employing Cupoline for repairing the lining of their 3-ton Stock converter. The method used is to mix the Cupoline with water to about the consistency of ordinary mortar a day in advance of its use, though it will keep indefinitely in the moist state so long as it is not exposed to heat. The patching is done by putting the Cupoline where required with a ladle; the heat in the lining is sufficient to dry the patch, and the converter is at once ready for service again. Our representative was informed that this use of Cupoline has prolonged the life of the vessel by at least 10 heats.

The Railway Plant and Foundry Company, Limited, Darlington, after an exhaustive test, have adopted Cupoline exclusively for cupola repair work. Mr. G. R. Young (managing director) informed our representative that Cupoline was an excellent non-conductor, and although they were using about one-fourth as much of it as of the refractory previously in service, he believed the life of the linings of the 12-ton cupolas had been increased at least 10-fold, and in point of fact he had not bought a brick for over eight months.

Finally, our representative visited the Thornaby Works of Messrs. Head, Wrightson and Company, Limited, where Cupoline was being employed for patching the side walls of the electric furnace, as also for seating the roof. Cupoline has also been used for ladle patching with satisfactory results, whilst a 30-cwt ladle for special manganese steel has been lined entirely with it. The material lends itself very readily for this last class of duty, as it may be moulded and tamped in exactly the same manner as concrete; that in point of fact is the method adopted for lining the ladle. The inside of the ladle is first damped with a slurry made of clay wash or Cupoline, and either daubed up or rammed with the Cupoline to a thickness of 1 in. to 1½ in. for small ladles and up to 3 in. for large ladles. The lining for the bottom of the ladle would be determined, in the case of bottom-pouring ladles, by the size of the stopper pot.

The material has been extensively used in this country, and the results of the trials which are available tend to show that there are considerable possibilities for its use alike in the blast furnace, converter, cupola, soaking pits and heating furnaces generally, whilst as a mortar for such structures, or for coke-oven work, it has serious claims for consideration.

The material may be stored in the open, its properties being wholly unaffected by climatic conditions; it is only matured by exposure to heat, and, as already stated, the heat usually present in the lining is sufficient to render the repair fit to stand fire, the material setting like adamant as the heat increases.

Belgian Steelworks and Foreign Contracts.

The recent success of Belgian steel works in securing contracts in international competition has induced a Brussels paper to compile from official sources a list of such orders booked during the current year, with special reference to German competition. Taking the Belgian contract prices at 100, the percentages of the German prices are said to compare as follows:—An order for 21,000 tons of rails for Holland, 101; 1,250 tons of rails for Brazil, 101; other railway material for Brazil, 105. In the case of contracts for Bulgaria:—5,800 tons of rails, 114; 1,600 tyres, 131; 101 tons of rail fastenings, 110; galvanised tubes, 125; and 50,000 steel sleepers, 116.

The results of the Belgian tenders for Bulgaria gave rise to the following comments on the part of a Sofia journal in February. Dealing with the rail contract it stated:—"Among the 14 firms who took part in this competition the Krupps firm offered a price of 4,000,000 levas (say £160,000 at par) in excess of that of the Belgian syndicate. The whole amount involved was 28,000,000 levas (£1,120,000 at par). This competition, as well as the others which have recently taken place, has raised great interest on the part of our merchants in Belgian goods, the price of which has become the lowest in the European market."

The Brussels paper has investigated also the foreign competitions which took place in 1921. Out of 49 competitions for which official results have been procured, the Belgian works were successful in 37 cases. German firms only participated in 30 of these competitions, and secured contracts in eight cases only, while the Belgians booked 22 of them. These tenders were invited by Argentina, Morocco, Brazil, Chile, China, Denmark, Rumania, Finland, Spain, Bulgaria and South Africa.

If wages in Belgium are reduced slightly, and makers lay themselves out for exports on common account instead of competing against each other, the journal thinks that it will be impossible for foreign rivals to beat the Belgians in international markets. The Société des Aciéries d'Angleur, of Liège, has just secured in open competition an order for 15,000 tons of rails for the Finnish State Railways. The price is stated to be 11 per cent. below the lowest German offer, and 22 per cent. cheaper c.i.f. Helsingfors than the lowest English quotation.

The Board of Trade give notice that they have received under Section 2 (1) (b) of the Safeguarding of Industries Act, 1921, complaints by the British Wire Nail Manufacturers' Association and the Pin, Hook and Eye and Snap Fastener Employers' Association in regard to the sale of wire nails and hooks and eyes manufactured in Germany, and snap-fasteners manufactured in Germany and Czecho-Slovakia. The Board of Trade have referred the matters for inquiry to a committee consisting of Sir Charles Stewart (chairman), Mr. F. J. Blakemore, Mr. T. P. Cook, J.P., Mr. Alexander Johnston, J.P., and Sir George R. Lowndes. The committee propose to hold their first sitting for the taking of evidence at 5, Old Palace Yard, Westminster, London, S.W.1, on Monday, May 4.

The Oliver Stubbs Medal.

The following rules governing the award of the Oliver Stubbs medal were approved by the General Council of the Institution at Manchester on March 25 :—

1. The Oliver Stubbs gold medal is presented by the National Ironfounding Employers' Federation to the Institution of British Foundrymen, under conditions already specified and accepted (see appendix), which require that the actual rules governing the award be formulated by the Institution of British Foundrymen.

The object of the gift is to encourage and reward efforts made by members of the Institution of British Foundrymen to impart knowledge to their fellow-members on the practice and theory of founding.

3. The General Council shall appoint a special committee to be known as the Awards Committee, to make recommendations for the award of the medal, which recommendations shall be submitted to the General Council for approval, and which may include two nominees, a first choice and a second choice, the grounds of their selection being stated.

4. The Awards Committee shall consist of five members, four of whom shall be equally representative of both the scientific and practical side of founding, the fifth member being the President of the Institution, who shall be a member *ex-officio*.

5. All members, associate members and associates shall be eligible to receive the medal who have completed twelve months' membership prior to the date of the award; none shall receive it unless his subscription, including arrears, be paid up to date.

6. The Oliver Stubbs Medal shall be awarded once each year, but in the event of the Awards Committee reporting that, in their opinion, no services of sufficiently high standard to merit the award have been rendered by any member of the Institution of British Foundrymen during the current year, the General Council shall have power to withhold the award, and to utilise in subsequent years the accumulation of funds thus caused, as they may see fit, strictly in accordance with the conditions governing the gift.

7. Any member, associate member, or associate who has received the award of the Oliver Stubbs Medal shall be ineligible to receive it again for the following four years.

8. Each Branch Council shall be asked to submit to the General Council for the primary consideration of the Awards Committee their recommendations for the award, together with the papers read or submitted, or a report giving details as to services rendered. Only two recommendations may be submitted in one year by each Branch Council, and the persons recommended must be members of the Branch, or unattached members of whom the Branch Council have knowledge. Recommendations must reach the General Secretary by May 1 each year.

9. The Branch Councils in making their recommendations to the Awards Committee, and the Awards Committee in formulating their final decision for the consideration of the General Council, shall be guided in their choice by the following fundamental principles. The Oliver Stubbs Medal is to be awarded to the member, associate member, or associate, who has rendered the most meritorious service during the year, by imparting knowledge to his fellow-members on the practice and theory of founding. Equal consideration must be given to

(*a*) Papers, or

(*b*) Services rendered by—

(1) Members with scientific attainments who may, for example, read papers of a highly scientific nature :

(2) Practical members who may be of great service in presenting the practical side of foundry work and the organisation of the same;

(3) Or in other ways render meritorious service to the Institution of British Foundrymen.

Equal stress is laid on practical and on scientific or academic services of a distinctive nature, partly because a practical Paper may be of equal or possibly greater service to the younger members, whom the National Ironfounding Employers' Federation particularly wish to encourage.

10. In the case of Papers, each Paper, whether of a practical or scientific nature, must be its author's own work, and must show evidence of originality. Sources of quotations and extracts must be acknowledged. It is compulsory that Papers should have been read either at any Branch meeting or at the annual conference.

11. All Papers or records of meritorious services rendered submitted by the Branch Council to the Awards Committee should if possible be typewritten, preferably on foolscap sheets and on one side only, and must be accompanied by the author's name and exact occupation, details as to when the Paper was read, and if already published and where. Illustrations and diagrams should be included as far as is possible, especially when important conclusions are based on diagrams or photographs as in photo-micrography. In cases where the authors have no facilities for typing the Paper it is suggested that secretaries of Branch Councils may easily be able to arrange this without incurring expense, possibly through the agency of some of the Branch members.

12. When the award is given for a Paper the General Council shall have the right to publish in the proceedings of the Institution, and also authority to utilise it for any other purpose at their discretion.

13. The award of the medal shall be announced prior to the annual general meeting which usually takes place in June. If the intended recipient is able to be present at the annual general meeting the presentation shall be made thereat, or if not, the presentation shall be made at a general meeting of the Branch.

14. The General Council reserve the right to modify these rules or to make additional rules, should this course be deemed necessary in the future, provided that such modifications or additions do not in any way interfere with the fundamental principles covering the award as laid out by the National Ironfounding Employers' Federation. Any such additions or modifications may, however, only operate as from the annual general meeting next following the date of such alteration.

APPENDIX.

The object of the National Ironfounding Employers' Federation in providing a gold medal is to encourage and reward efforts made by members of the Institution of British Foundrymen to impart knowledge to their fellow-members on the practice and theory of founding.

Conditions Governing Gift of Medal.

That the principal sum of two hundred pounds given by the National Ironfounding Employers' Federation shall be invested in the names of the trustees of the Institution of British Foundrymen, who shall have power, with the approval of the Council of the said Institution of British Foundrymen, to change the investment from time to time, and a separate account of such trust shall appear annually along with the balance-sheet of the Institution.

That the Trustees of the Institution of British Foundrymen undertake to apply the annual income from the aforesaid investment for the purpose of providing a gold medal from dies to be supplied by the National Ironfounding Employers' Federation. The medal to be called the " Oliver Stubbs " Medal.

That the Council of the Institution of British Foundrymen or such other body of members whom they may appoint will award the " Oliver Stubbs " Medal to the member who, in their opinion, has rendered the most meritorious service during the year to help forward the object for which the medal is given.

That in the event of the Institution of British Foundrymen ceasing to exist the Trustees of the said Institution shall return the capital sum of two hundred pounds to the National Ironfounding Employers' Federation, or in the event of the said National Ironfounding Employers' Federation having ceased to exist, to hand the said capital sum of two hundred pounds to such National Charitable Society or Institution as they in their own discretion may decide upon.

The Council of the Institution of British Foundrymen shall have power to make rules to govern the award of the medal.

Institution of British Foundrymen.

SHEFFIELD BRANCH.—ANNUAL MEETING.

There was a large attendance in the Cutlers' Hall, Sheffield, for the annual meeting of the Sheffield Branch of the Institution of British Foundrymen, over which Mr. John Watson, the outgoing chairman, presided.

Before the business of the meeting was proceeded with the Chairman referred to the death of Dr. A. McWilliam, a well-known Sheffield metallurgist, who, he said, had always taken a great interest in metallurgy and engineering in Sheffield. In the early days of their association he had helped them very much, and the Council of the Branch had directed the Secretary to forward an expression of their sympathy with Mrs. McWilliam in the loss she had sustained.

The meeting unanimously approved of the action of the Council.

The election of officers of the Branch was then proceeded with, and resulted as follows: President, Dr. T. Swinden; senior vice-president, Mr. J. Shaw; junior vice-president, Dr. Desch; elected to vacancies on the Council, Messrs. Gummer, Junr., Stiggles, and Webster; auditors, Capt. Moorshead and Mr. J. Green; secretary, Mr. W. A. Mac Donald; assistant secretary, Mr. J. Kayser. The following were appointed delegates to the National Council: Messrs. J. R. Hyde, J. Watson, J. Bagnal, and Ambrose Firth.

A vote of thanks was passed to the outgoing chairman and officers for their services during the past year.

CORE-MAKING.

Mr. J. G. Robinson, of Halifax, said to all moulders and core-makers the term "core" in connection with foundry work was distinctly understood to mean any part of a mould which produced a hollow in, or a hole through a casting. A somewhat different definition appeared in a popular weekly, and humorously referred to by The Foundry Trade Journal, which was read by Mr. Robinson. His idea in initiating a discussion was to bring to their notice that where sand mixtures were concerned, many people considered their own mixture as the best for certain classes of work. No doubt they were justified in thinking so, but for the purposes of discussion he would like to refer to a present-day tendency. That was the use of artificial binders for the purpose of using up old sand to save casting and to save time core-making and fettling, and the reduction of casting risks. Artificial binders could be divided in (1) water soluble binders, such as molasses, glutrin glue, etc.; (2) paste binders, which included flour, starch, and dextrine; (3) gum binders, which included resin, pitch, and tar, and oil binders. He desired particularly to point to the advantages of oil-bonded cores, and in this respect he commended to the notice of the meeting an exceptionally good paper on the subject which appeared in The Foundry Trade Journal on March 2, by Mr. J. Masters, of Stockport. Amongst the numerous advantages gained by the use of oil-sand cores were: The increased number of cores produced, the ease with which the cores were removed from the castings, the ease with which the cores were dressed and blacked, where blacking was necessary; the small number of broken cores returned from the moulders when closing their work, and the small number of blown castings from the core point of view.

Mr. Robinson then exhibited a large number of cores.

The increased output was easily demonstrated by a sample radiator core, which he exhibited. If this core were made in ordinary clay-bonded sand it would require some ironing. It would also require venting much more than was done in the instance shown, which was done with oil-sand. A certain amount of tackle was necessary for that class of work because it was made in a cast-iron dish for the bottom part, in which it was carried into the stove and dried in place. The vents were pressed in on the joint by means of a plate specially prepared. Very little ramming was necessary. In fact, in many cases, where simply tucking in with the fingers would be sufficient, some people rammed hard—so hard that they would not leave the box. No irons were used in the sample shown.

The same remarks applied to a new type of radiator core, which he also showed.

The next core shown was a boiler section core, which, he said, was an example where simple jointing could be done by drying one half on a flat joint, making the other half core, and using the dried half to carry the second half.

These two cores he submitted as good examples to demonstrate the necessity of ease in fettling and removing the core from the casting.

Another core shown was a steam chest core, made, he said, in one-tenth the time it used to take in the old days to make the core iron. It bore out a remark made in Mr. Masters' paper, which stated "It is also essential to have the best assistance from the pattern shop."

Mr. Masters, he continued, had referred to the disadvantages of oil-sand cores, and the chief, he said, was that large oil-sand cores would not stand handling when green. That was a fallacy, as he and many people who had carried out experiments had proved.

Mr. R. O. Patterson,
The Newcastle-on-Tyne Branch President of the Institution of British Foundrymen. Mr. Patterson is connected with the firm of Smith, Patterson & Co., Ltd., of Blaydon-on-Tyne.

Proceeding to prove his contention, Mr. Robinson, with the aid of two friends who accompanied him, Messrs. Edginton and Parker, made, for the benefit of the meeting, a number of cores, which passed scrutiny satisfactorily.

Discussion.

Mr. John Watson, in proposing a vote of thanks to Mr. Robinson and his friends, said he considered the introduction of these cores one of the greatest developments of modern times in the steel foundry. The only difficulty he experienced was not to get the core made, but to get it dried properly: they were usually overheated. He would like to know if they were dried at a low temperature.

Mr. Robinson: Not necessarily. It has got to be over 500 deg. C. before it will burn out. An oil-sand core would stand 1,500 deg., as in a steel foundry.

One, which he indicated, was subjected to 450 to 500 deg. for 2½ hours and was not burned. Another contained equal amounts of new and old sand with oil. By that plan they could use up their old sand.

Mr. Darley congratulated Mr. Robinson on the excellent samples he had shown, and said that he had made cores up to 9 in. in diameter with only

a few rods in. But his difficulty was to hold the first half together. He knew there was a lot of prejudice against this type of core, particularly amongst the older foundrymen.

Mr. Robinson said that where there were different sizes in the chamber of the core it needed striking up. He never thought of making a long core without some support.

Mr. Darley said he had experienced difficulty with a job 20 in. in dia. and cores 3 ft. long. He had the difficulty of expansion. The metal running up had a tendency to strain the cores.

Mr. Robinson said he would recommend in steel practice to use a certain amount of compo opposite where the runner had to come.

LANCASHIRE BRANCH.

Discussion on Mr. R. Dunkerley's Paper on Foundry Accounts, Costs and Statistics.*

The Chairman (Mr. W. K. Meadowcraft) said after hearing Mr. Dunkerley they could realise that many difficult questions came up for consideration in costing. Perhaps the most interesting one was the provision which should be made for wasters. What was the method adopted by Mr. Dunkerley? Did he put a percentage on the cost of the individual jobs?

Mr. Dunkerley replied that if wasters were charged back to overhead expenses the cost of the job was automatically increased. There was another way of looking at the thing. They arrived at the cost of the material, and divided by the number of good castings. Obviously an increase was automatically put on.

The Chairman said usually, when estimating for a job, it was just a question of taking the first cost. Now if it had been a risky type of casting and there had been bad luck with it, the cost might come out high. Was it the custom to quote on that basis?

Mr. Dunkerley pointed out that there was an item, "defective workmanship," which would cover the wasters. That increased the overhead expenses which were spread over the whole of the production, and it was allowed for in the quotation for the job.

The Chairman said perhaps they were looking at the matter from different points of view. In justice to the foundryman, a certain percentage should be put on for risky castings; otherwise there was a danger of quoting too low. Recently a firm who had a big foundry of their own had sent out drawings for work which was exceedingly risky, and no one had any data to guide him in estimating the price he should take, so that it was a gamble. Probably the foundryman would put a lump sum down for the risk. One could demonstrate on paper, but when the work got into the shop there were so many things to take into account, some so obscure, that one could hardly get hold of them, that it was very easy to make a serious mistake.

Classification of Wasters.

Mr. Dunkerley said before costing could make headway in foundries the idea must be eliminated that the intention was to interfere with the foreman moulder. A proper system should be of help to him. With regard to wasters and the adjustment of quotations, if a job had been made before, they were not guessing, but knew what they might expect, and the price could be fixed accordingly. Putting a little extra on was really for insurance, making provision for the element of risk. Suppose castings were divided into four classes. The foundryman knew whether a job would normally come into, say, class 3, and if he thought it was a risky thing he could put it into class 4.

Uncertainty of Labour Costs.

Mr. Jolley described the method adopted in the foundry he was connected with. According to whether the casting was faulty through machine-shop trouble, or bad workmanship, or material, a separate form was filled up. The particulars were entered upon a card. Then if at a future time a similar job was in hand, the foreman would call for that card and he would know what the job actually cost, as well as what the cost ought to be.

Mr. J. Simkiss said this subject had been much neglected by the Institution in the past. Speaking from the point of view of a large jobbing shop, it appeared to him that a system worked out on the lines indicated would cost a great deal. What happened in the foundry? An inquiry came along for a casting or a number of castings, and it was sent to the manager in order that a price for labour might be fixed, the overhead charges, with the cost of materials, being left to the cost office. Everything depended on the ability and judgment of the manager. He might miscalculate in his estimate of the time it might take. It might be that one foundry possessed the tackle needed to do that job efficiently, and another foundry did not; that would make a difference in the quotation. The speed of the workmen was another uncertain factor. He recalled a job which when it first came into the shop was given to one man on piecework, and he did it in two days. Later, when that job was sent in again, it was given to two men on day work, and they took four days. If it had been costed on the basis of the first man's time it would have proved very expensive for the firm. So many things cropped up in foundry practice that costing was a very difficult matter.

He understood Mr. Dunkerley to say that when extra tackle had to be made specially for a job, the cost of it should be charged to the purchaser. It seemed to him that was rather impracticable. He had never come across a purchaser who would pay for tackle which had to be scrapped afterwards. He quite agreed that there must be a spout charge, with the exception of particular mixings.

Another point which occurred to him was that in a 5-ton job the extra metal necessary for heads and overflow, and that sort of thing, would be a small percentage in comparison with very light work where, perhaps, the runners would be from 50 to 75 per cent. In dealing with the latter, the percentage of metal melted to the quantity of casting produced, must be taken into consideration.

He did not altogether agree with the author's remarks about labourers. Many times the time occupied by a job was quite as long after a labourer had been put on to assist as before he was put on. With regard to scrappers or wasters, in his own foundry those were weighed out every week, and the returns which came in were taken weekly and monthly. As a rule the percentage was low, and it was spread over the whole bulk of the work, and not allocated to specific jobs. In his own shop the percentage of wasters was less than 2 per cent., and the returns were less than 1 per cent.

Collected Information the Essence of Costing.

Mr. Dunkerley said Mr. Simkiss collected information that was the essence of costing, although Mr. Simpkiss might use some other name for it. The extent to which one should go into detail depended upon the size of the works. Where only a few men were employed it would not be necessary to take separately all the items which he had set out. Admitting that the costing of individual jobs was difficult, how much more difficult must it be for a manager who had no records to recall what had been done when the work was in the shop before and take that as the basis for a quotation. Take the case of the job which was done by one man in two days and by two men in four days. But after all, the foundryman did not quote on what one particular man did; nor, for that matter, purely on what his own costs were; the market had always to be taken into account, and if the cost came out more than the price which enabled one to compete successfully in the market, what advantage was it to get the order? All the factors must be kept in mind. Suppose special tackle had to be installed to do a certain job and was afterwards scrapped. If at the end money was going to be lost, it was better to cut out that job. Why should anyone want to take work which was unsuitable for his foundry? Sometimes people wanted to keep their workmen together, and were willing to reduce their rates with this object. They should know exactly what it cost them to do that, and not be content with just an impression. For that purpose costing was essential. As to the question about the labourers, it was information worth having that a job cost more on one occasion with a labourer than without one, and whatever name it was called by, putting it on record was costing. It was not necessary to have an elaborate system in a small foundry; it must be modified as circumstances required; the essential thing was to keep accurate records.

* This Paper was printed in March 30 and April 6 issues of the Journal.

Mr. Simkiss remarked that with regard to the extra tackle, the point he wanted to emphasise was that when the casting was of a special character, if the purchaser would make inquiries of the foundries already equipped to deal with that class of work, and had the necessary tackle, the purchaser would get both the best results and price. If it was necessary to make extra tackle, its cost should be included in the quotation given, and if that was too high that founder was out of the market altogether.

The Effect of Apprentice Labour on Costings.

A visitor asked what was the best method of allocating overhead expenses when a job had been made by youths instead of by men.

Mr. Dunkerley said instead of allocating the overhead expenses on the basis of a percentage of the men's wages, they could be reduced to so much per hour; that is to say, taking the average expenses and the average number of hours over a normal period. In that case the average was the same for boys as for men, because the former were using as much, or even more, time, and so on. It was a difficult problem, but he knew it was being solved successfully.

The Possibility of Too Much System.

Mr. Key said a system could be carried too far. He was not saying that Mr. Dunkerley did that, but he would mention an incident that occurred when he was at a certain works. There were no records available in the foundry office, and in conversation with the manager he commented on this. The manager replied, "So and so," mentioning a competing firm, "make a job for a penny and it costs them 2d. for system; we make it for 2d., and it costs us ½d. for system. We pay a dividend and they do not."

In making an estimate a foundryman would put on the direct labour cost—core-making, moulding and fettling—and allow a fixed percentage for ordinary risk if it was a straightforward job; if it was of a special character he would put on something extra. Then, if he was particularly anxious to get the work, he might take the responsibility of omitting that percentage. If he did not do so it might go to somebody who knew nothing about it, and would lose money in the end. That was an ordinary rule-of-thumb method, to allow a percentage for contingencies. Detailed foundry costing was a very expensive proposition; more so than in any other branch of the engineering industry. There might be statistics showing what had been done before in allocating charges, the cost working out to so much, but it did not follow that the same results would be obtained. On the first occasion the work might have been done by a good workman; the second time it might get into the hands of someone else who did not work so well. With one man a barrowful of sand would go round, where others would want three or four. They were bound to take into account the law of averages. Knowing whether it was to be done piece-work or day-work, they could work it out on that basis, and if the prices were worked out on the average standard they would not be far wrong. In his opinion it was the least costly method of keeping accounts and statistics, and in a small establishment they wanted the system to be as simple as possible. Of course, in some cases it was quite necessary to have details.

Mr. Dunkerley said he did not think the system would prove as costly as some people seemed to fear. If the cost was 3 per cent. of the total turnover it was time to examine it. In a small works the costing would probably be done by the clerks, in addition to their other work. Whatever name it might be called by, the foundryman should have information which enabled him to decide what his price should be. It was the man who guessed who failed. The principle of an established system of costing had been adopted in America to a much greater extent than here, but in this country it had been put into force by the master printers. They established a standard costing system for all printers, and men went about from one place to another explaining it. They were all competing on the same basis. In many cases the prices had gone up because they found they had been taking prices that did not pay them.

A vote of thanks to Mr. Dunkerley concluded the proceedings.

Building Exhibition.

The Building Exhibition was opened on April 11 at Olympia, London, by Mr. Paul Waterhouse, M.A., F.S.A., and will remain open until the 27th inst. The exhibits include the following:—

Baldwins, Limited, 3, St. Helen's Place, Bishopsgate, E.C.3.—Painted and galvanised export tanks, galvanised riveted cisterns, hot-water tanks, welded cylinders, coal bunkers, etc. Galvanised corrugated and flat working-up sheets. Curved corrugated sheets for concrete flooring.

The Brightside Foundry & Engineering Company, Limited, Sheffield, and Chicheley Street, London, S.E.1.—Murray's continuous delivery brick machine; Pullan & Mann's special power-driven roofing tile press, to press about 10,000 tiles per day; Pullan & Mann's screw-pipe machine, for producing earthenware and stoneware pipes, complete with sockets, at one operation; Clayton's horizontal continuous feed "two process" pipe and tile machine for making drain pipes, flooring tiles, common roofing tiles, etc.; Clayton's hand-lever portable brick press, to press 4,000 bricks per day.

Carron Company, Ironfounders and Engineers, 15, Upper Thames Street, E.C.4; 50, Berners Street, W.1.—Fireplaces, ranges, sanitary appliances, ornamental constructional ironwork, staircases, spiral and straight.

The Fairfield Supplies Company, Limited, 8, Goring Street, St. Mary Axe, London, E.C.3.—The "Skylux" patent cordless window fanlight and skylight stays, operated entirely without cords, pulleys or levers; the Skylux universal multiple gear operates a range of windows simultaneously and controls each independently; the "North" tube and rod bender, for bending electrical tubing.

The Ironite Company, Limited, 9 and 11, Old Queen Street, Westminster, S.W.1.—"Ironite" brand cement for constructing wearproof, dustproof, waterproof and greaseproof floors for machine shops, engineering works, coalbunkers, dock quays, warehouses, power stations, etc. Marion steam and electric shovels, Kilbourne & Jacobs automatic air dump cars, concrete mixers, Watson bottom-dumping wagons.

Ransome Machinery Company (1920), Limited, 14/16, Grosvenor Gardens, London, S.W.1.—Exhibits include an extensive range of concrete mixers, concrete-hoisting and placing equipment, including section of steel tower, hoist bucket, friction winch, receiving hopper, chutes, etc.; tar macadam plant; steel piling and piling plant.

Sturtevant Engineering Company, Limited, 147, Queen Victoria Street, London, E.C.4.—Sturtevant turbine vacuum-cleaning plants for stores, offices, factories, mills, etc. The Sturtevant new design No. 12 type turbo-exhauster is also shown.

Sutcliffe, Speakman & Company, Limited, Leigh, Lancs.—The Emperor press, adapted for making lime sand and other bricks, and for briquetting ores, flue dust, coal and similar materials. The press consists of a horizontal rotating table containing 9 to 12 moulds. The table rotates one mould at a time in such manner that while one mould is being charged, another is under pressure, and a third under the discharging ram. The feeding is automatic, and pressure can be regulated at will. The press is of high-class design and robust construction, and is made in three sizes. A pug and ball mill for tempering stiff clay is also exhibited.

Vickers, Limited, Vickers House, Broadway, Westminster, S.W.1.—Portable concrete machinery; portable concrete brick machine, designed to make concrete building-bricks of standard English dimensions; any thickness up to 4 in. can be obtained, and by a few simple adjustments, various types of bricks may be made, such as arch bricks, flooring brick and tiles, without any additional apparatus; portable concrete roofing-tile machine; portable concrete partition slab machine.

Large Heroult Furnaces. — According to Mr. J. M. Hall, in electric furnace work the most striking development of the past year has been the successful starting up of the 40-ton Héroult electric furnaces in the U.S. Government armour-plate plant. These furnaces are round with a shell 18 ft. in diameter and 8 ft. high, with 18-in. brick walls. Three electrodes are used 24 in. in diameter for amorphous carbon, and 14 in. for graphite, which has been tried experimentally. The furnaces take hot metal from two basic open-hearth furnaces, in which the phosphorus is reduced to about 0.015 per cent.; in the electric furnace the metal is refined and the sulphur brought down to between 0.008 and 0.015 per cent. The next step will be to a much larger furnace; the 100-ton electric furnace is in sight.

French Steel Output.

According to the returns received by the French Comité des Forges, the total output of steel in France in 1921 was 3,102,170 tons, of which 3,005,454 tons were ingots and 96,176 tons castings. The total represents an increase of 915,910 tons on the 1919 figure and 51,774 tons on the total of 1920. The increase was in ingot production.

Of the 3,102,170 tons of steel output, 1,779,860 tons were basic Bessemer steel, 45,094 tons were acid Bessemer steel, 1,243,216 tons open-hearth steel, 9,543 tons crucible steel, and 24,457 tons were produced in electric furnaces. Of the total, 66.1 per cent. were produced in the Eastern district and in Alsace-Lorraine against 59.4 per cent. in 1920.

The steel works consumed 18,579 tons of ore, 28,709 tons of acid Bessemer pig-iron, 2,035,047 tons of basic Bessemer pig-iron, 9,548 tons of low-manganese pig-iron, 249,154 tons of forge pig-iron, 119,653 tons of special pig-iron, and 1,056,697 tons of scrap, etc.

The plant in 1921 included 40 acid converters, 54 basic converters, 90 open-hearth furnaces, 13 crucible and 13 electric furnaces. The number of workpeople in 1921 was about 71,000.

The total output of finished products in 1921 was 2,188,714 tons, of which 267,750 tons were rolled joists and other shapes, 292,946 tons rails, 292,154 tons plates and sheets, 74,687 tons universal flats, 759,014 tons bars and commercial steel, 18,004 tons were hoops, 48,208 tons tyres, 10,348 tons springs, 36,729 tons fishplates, sleepers and sole plates, 118,525 tons wire rods, 87,906 tons wire, 30,468 tons tubes, 78,345 tons castings, 40,579 tons forgings, 16,402 tons tinplates, and 17,249 tons were finished products of other descriptions.

The Comité des Forges report that on February 1 last, there were 196 blast furnaces in France, of which 66 were in blast, 74 were ready to be blown in, and 56 were reconstructing or being overhauled and repaired. By March 1 the number of blast furnaces was increased to 207, of which 76 were in blast and 72 were ready to be blown in. The French pig-iron output in February last was 323,093 tons, compared with 311,815 in January. The output of steel ingots and castings was 316,705 tons in February, as compared with 314,598 tons in January last.

Death.

Mr. J. Livingston, of Well Close, Rothbury, died recently. The deceased, who was born in 1857, was the eldest son of the late Mr. J. Livingston, of Jarrow, where he served his apprenticeship as an engineer with Palmers Shipbuilding and Iron Company, Limited, and was afterwards with the Wallsend Slipway and Engineering Company, Limited. He became chief draughtsman with Westray, Copeland & Company, Limited, of Barrow-in-Furness, about 1885, and chief draughtsman and afterwards manager of the engine works of Messrs. Harvey & Company, of Hayle, Cornwall. About 1895 he commenced business on his own account at Great St. Helens, London, E.C., as a consulting engineer, and founded the business of James Livingston, Limited, Imperial House, Kingsway, London, W.C. He retired from the active management of this business in 1911, owing to ill-health.

Personal.

Major G. H. Willis has been elected president of the Indian Institution of Engineers.

The late Mr. Henry William Tonks, of 151, Holly Road, Handsworth, retired engineer, left estate valued at £12,823.

The late Mr. J. Prosett, a director of the Westwood Engineering Company, Limited, left £55,216, with net personalty £46,821.

The late Mr. T. Gwynne, managing director of Gwynne & Company, Limited, left estate of the gross value of £3,768, with net personalty £3,699.

Mr. Sam Atherton, mining engineer, has been elected as a member of the Pontesbury (Salop) Rural Council. Other successful candidates include:—Mr. W. A. Hales, engineer, Market Drayton Rural District Council; Mr. Wm. Savage, mechanical engineer, Crewe Board of Guardians; Mr. J. E. Shaw, manufacturer and iron merchant, Rowley Regis Urban Council; Mr. W. E. Hicks, iron and steel merchant, Heath Town Urban Council; Mr. C. W. Thompson, engineer, Bilston Urban District Council; and Mr. C. H. Pinson and Mr. J. A. Harper, lock manufacturers, Willenhall Urban Council.

Company News.

D. W. Tunnard, Limited.—Capital £5,000. General engineers. Directors: D. W. and Mrs. E. H. Tunnard.

National Steel Company, Limited.—Capital £15,000 in £1 shares. Registered office: Princes End, Tipton, Staffs.

Dieny & Lucas, Limited. — Capital £30,000 in £1 shares. Engineers. Registered office: 329, High Holborn, W.C.

Southam Nail Company, Limited.—Capital, £7,000 in £1 shares. Registered office: 31, Cannon Street, Birmingham.

Wing & Webb, Limited.—Capital £5,000 in £1 shares. Metal workers. Registered office: St. James's Square, Wolverhampton.

West Hunwick Silica & Firebrick Company, Limited.—Capital £5,000 in £1 shares. Registered office: West Hunwick Colliery, Durham.

Clarendon Coal Company, Limited.—Capital £10,000. Directors: Mrs. J. W. Jones, Mrs. L. Jones and J. S. O'Neill. Registered office: 41, Pilot Street, Belfast.

Edgar Fitton & Company, Limited.—Capital £3,000 in £1 shares. Engineers. Directors: Edgar Fitton and Mrs. E. Fitton. Registered office: 295, Charter Road, Manchester.

Hadens Engineering Company, Limited. — Capital £15,000. Directors: W. N. Haden, C. I. Haden, and D. Glasgow. Registered office: 199, Great Brunswick Street, Dublin.

Aston Cross Manufacturing Company, Limited. — Capital £8,000 in £1 shares. Engineers. Directors: T. Carter and W. Low. Registered office: 1, Portland Street, Aston, Birmingham.

France & Morgan, Limited.—Capital £20,000. Brassfounders, etc. Directors: R. Morgan and A. Morgan. Registered office: Whitefield Brass Works, 44, Carmichael Street, Govan, Glasgow.

A. Peckston, Limited.—Capital £1,000. Electrical engineers, etc. Permanent directors: A. Peckston (managing director) and A. E. Foster. Registered office: 42, Wilson Street, Middlesbrough.

Stannic, Limited.—Capital £2,000 in £1 shares. Engineers. Directors: J. MacLaughlin, R. P. Marshall, and W. D. M. Wilson. Secretary: H. J. Rich. Registered office: 147, Cottenham Road, Upper Holloway, N.19.

Robert Heath & Low Moor, Limited.—Loss for year, £239,256; brought forward, £82,334; transferred from capital reserve, £154,907; balance, £2,014; debenture interest for year, £69,256; debit carried forward, £71,271.

Gardners, Limited.—Capital £20,000. Manufacturers of and dealers in machinery, tools, etc. Permanent directors: F. G. Gardner and Mrs. E. L. Gardner. Registered office: Century Tool Works, Broadmead, Bristol.

Manganese Bronze & Brass Company, Limited.—Recovered from Government and others, £13,091; profit, £16,171; balance of expenses of debenture issue, £2,000; preference dividend, £10,126; brought forward, £13,941; carry forward, £17,986.

Clayton & Shuttleworth, Limited.—Profit, £31,588; depreciation, £12,706; brought forward, £53,532; available balance, £78,414; half-yearly dividends on 5 per cent. cumulative preference, £17,500; no ordinary dividend; carried forward £54,914

Palmers (Swansea) Dry Dock Company, Limited.—Capital, £200,000 in £10 shares, to adopt an agreement with Palmers Shipbuilding & Iron Company, Limited, and to carry on business as dock and ship builders, etc. Registered office: 116, Fenchurch Street, London, E.C.

Gazette.

Trading under the style of the Mackinnon Castings Company, Messrs. W. Cartwright Mackinnon & H. D. May, 15, Belmont Row, Birmingham, casters of brass and other metals, have dissolved partnership.

The partnership hitherto subsisting under the style of R. Armitage & Company, Ferrite Foundry, Oldham, has been dissolved by mutual agreement, on April 5, Mr. D. Cooper, of Cooper, Newell & Company, Bindloes Chambers, Chapel Walkers, Manchester, having been appointed as receiver of the assets and effects of the partnership business to whom all communications on the matter should be addressed.

Steel Industry in Chile.—The development of the steel industry in Chile, which began many years ago with the blast furnace at Corral, has been greatly hampered by the world-wide depression. Nevertheless, the Compania Chilena Electro-Metalurgica is enlarging its plant, which now has a capacity of 2,000 tons of steel a year. This Company sells all the steel produced to the State Railroad. The Government has recently cancelled a contract awarded to an Italian firm for the supply of armament valued at 11,000,000 lire (£440,000 at par).

Trade Talk.

W. & G. POLLOCK & COMPANY have removed their offices to their new establishment, Wellshot Engineering Works, Cambuslang.

THE SUPERHEAT FURNACE COMPANY, LIMITED, formerly of 21, Morley Street, have removed to 16, Adolphus Street, Bradford.

THE ECONOMIC (ENGINEERS AND WELDERS), LIMITED, of Milton Avenue, East Ham, have removed to Chaplin Street, West Ham, London, E.15.

THE POSTMASTER-GENERAL announces that the air mail letter service between Great Britain and Holland, which was suspended during the winter months, will be resumed as from Friday, April 21.

THE VICTORIA BRASS FOUNDRY COMPANY, LIMITED, Bonnington Road Lane, Edinburgh, have appointed Mr. A. Scott, engineer, Parksworth House, 30, City Road, London, E.C.1, to represent them in the London district.

MONS. L. GOMBERT, Etablissements Eole, 59, Rue Condorcet, Paris (9), has been appointed sole agent and licensee in France and Italy for the patent wet-air filter manufactured by Princeps & Company, Matilda Street, Sheffield.

AT a meeting of the Manchester Metallurgical Society, held on April 11, Mr. W. Wilson was elected president for the coming year; Dr. Gwyer, Mr. Cartland and Dr. Thompson vice-presidents; Mr. Evans, secretary, and Mr. Hirst, treasurer.

LAST WEEK the s.s. "Felspar," of Glasgow, arrived at Harrington from Spain, with a cargo of about 1,000 tons of Spanish ore for the United Steel Companies, Limited. This is the first cargo of foreign ore that has arrived at Harrington for a long period.

IN CONNECTION with the Graduate Section of the North-East Coast Institution of Engineers and Shipbuilders, Mr. T. A. Crowe (Graduate) lectured in the Mining Institute, Neville Hall, Newcastle, recently, on "Some Possible Developments in Steam Reciprocating Marine Engines and Boilers."

AMONG the British manufacturers to be represented at the Rio de Janeiro Exhibition, which opens on September 7 next, will be Nobel Industries, Limited, who have notified the Board of Trade of their intention to support the British section which is being organised by the Department of Overseas Trade.

THE Calcutta Electricity Corporation have placed orders in this country with the English Electric Company, Limited, for a 15,000-k.w. turbo-generator; the Stirling Boiler Company, Limited, for boilers, the British Thomson-Houston Company, Limited, for transformers; Hick, Hargreaves & Company, Limited, for condensing plant; and Henley's Telegraph Works Company, Limited, for cables.

H.M. CONSUL at Cluj (Transylvania, Roumania) reports that the Municipality of Cluj is endeavouring to arrange for the construction of a pipe line for the supply of natural gas from the Kissarmas district (60 k.m. distant) for domestic, commercial and industrial purposes in Cluj (previously known as Klausenburg or Kolozsvar), and it is probable that tenders will shortly be called for. Full particulars may be obtained from the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

SIMPLEX CONDUITS, LIMITED, Garrison Lane, Birmingham, have recently effected changes at the Simplex and Credenda joint sales depôts at both Cardiff and Newcastle, mainly as the result of Mr. A. G. Robson's resignation from the management of the latter office. Mr. J. Entwistle, from the Cardiff office, has been appointed as manager of the Newcastle and district branch, and has been succeeded at Cardiff by Mr. H. E. Barringer, who has been connected with the depôt at Bristol for a considerable period.

AMONG THE MORE IMPORTANT ORDERS recently received by the Underfeed Stoker Company, Limited, we note travelling grate stokers for the Eastbourne, Marylebone, Wolverhampton, Stafford, Liége, and Cossipore (India) electricity undertakings; Harworth Main Colliery, Consett Ironworks, Scottish Oils, Limited, Gt. Mountain Colliery and Stockholm Gas works also for travelling grates; Steel Company of Scotland and Tate & Lyle for underfeed stokers, and the Borough of St. Pancras and Philadelphia Colliery for ash conveyors.

THE COUNCIL of the Institution of Civil Engineers have made the following awards for papers read and discussed during the session 1921-22:—Telford medals to Sir Henry Fowler, Mr. H. N. Gresley and Mr. H. F. Parshall; a Watt Medal to Mr. William Willox; an Indian Premium to Mr. F. G. Royal-Dawson; Telford Premiums to Mr. A. W. Rendell, Mr. W. F. Stanton, and Mr. A. C. Walsh. The council have also made the following awards for papers printed without discussion in the "Proceedings" for the session 1920-21:—A George Stephenson Medal to Mr. J. H. Taylor; Telford Premiums to Mr. F. H. Hummel, Mr. E. J. Finnan, and Mr. Herbert Chatley; and a Trevithick Premium to Mr. G. E. Lillie.

THE salaries paid to the Chief Labour Adviser and the President of the Industrial Court are severely commented upon by the Select Committee on Estimates in a report issued dealing with the Estimates of the Ministry of Labour. There is a foot-note in the Estimates which states that the post of Chief Labour Adviser "is to be re-considered on the occurrence of a vacancy." The Committee are of opinion that "a gentleman competent to advise on Labour matters could be obtained at a much less salary than £3,000 a year. It is believed that the department prefer that the occupant of this post should have been at one time connected with the Trade Union movement, but it does not appear to your Committee that there would be any difficulty in obtaining an official of a Trade Union at a far less salary than £3,000 a year, which, it must be remembered, carries a pension for life."

AT THE EXPIRATION of three months the names of the undermentioned companies will be struck off the Register of Joint Stock Companies, and the companies will be dissolved:—Clayton Metal Company, Limited; Colonial Engineering Agency, Limited; Denton Electrical Construction Company, Limited; Electro Galvanizers, Limited; Holmquist Electric Company, 1911, Limited; Humphris Engineering Syndicate, Limited; Humphris Patent Gear and Engineering Company, Limited; Leyton Engineering Company, Limited; Reynolds Steel Inventions, Limited; Standard Turbine Company, Limited; Suffolk Iron Foundry Company, Limited; Vallongo Antimony Company, Limited; Victoria Stamping Works, Limited; and Woodward-Weddell Steel and Engineering Company, Limited.

IN REGARD to the settlement arrived at in the case of Farncombe v. Sperling & Company, which arose out of the Baldwins share deal proposal, it is now officially announced that 99 per cent. of the shareholders supporting the action have accepted Messrs. Sperling's offer to settle all matters in dispute on the original contract on the following terms:—The shareholders have the option to retain their shares and receive by way of damage 32s. 6d. per share, or of transferring their shares to Messrs. Sperling on payment of 47s. 6d. per share. In both cases the shareholders retain all dividends paid by Baldwins, Limited, up to date. The defendants have agreed to provide and pay into joint names the necessary cash to meet the above obligations on or before April 27, and, further, to pay the plaintiff's cost in the action. On due performance of these terms all proceedings are to be stayed, otherwise Mr. Justice Coleridge's judgment for specific performance is to stand without any right of appeal therefrom.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Iron Foundry Cupola Practice.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Mr. Shaw in last week's issue of THE FOUNDRY TRADE JOURNAL agrees to accept my offer in the issue of April 13, and then goes on to stipulate certain conditions.

In the first place my reason for putting the cast at 10 tons was because our foundry is not large enough for a greater amount.

I am quite agreeable to the composition of the charges being as suggested by Mr. Shaw, and although we may be some distance from the centre of the iron and steel industry, we are not in the habit of spending 12s. in labour to save 3s. worth of coke, either with scrap or in any other direction.

I also agree to the class of castings stipulated by Mr. Shaw if he will supply us with the orders for the same at a fair market price. I am compelled to make this condition, as Mr. Shaw undoubtedly must know the difficulties that exist at present for getting orders at all, let alone to select the class of work we would prefer to have.

On the question of tuyeres, I can assure Mr. Shaw that the cupola is the standard type of a well known make, and I have no intention of manipulating them as suggested by Mr. Shaw.

With regard to arbitrators, I have not the pleasure of knowing Mr. Cook, but am quite prepared to accept him as an arbitrator. However, if Mr. Shaw has the privilege of nominating one arbitrator, I think he will agree I should have the right to nominate the second one.—Yours, etc.,

J. J. MCCLELLAND

Palatine Works, Worton Road, Isleworth.

[This correspondence is now closed.—ED.]

IRON AND STEEL MARKETS.

Pig-iron.

Resumed after the Easter vacation, business in the principal pig-iron markets has disclosed few developments of importance, the majority of buyers preferring to hold off until the labour situation in the consuming industries shows signs of approaching settlement. This result, it is feared, will be delayed by the failure of negotiations so far, and it can only be hoped that wiser counsels will prevail in order to obviate a complete breakdown of the protracted attempts at an amicable conclusion of the dispute. Meanwhile it is satisfactory to learn that the moulders' section of the foundry trade is not yet involved to any considerable extent in the engineering lock-out, which still leaves some outlet for home consumption of foundry pig, but for the present the business continues restricted, most of the South Staffordshire furnaces remaining idle, the bulk of local supplies being derived from Derbyshire and Northamptonshire, quotations for which are unchanged. The Scotch pig-iron market is practically stagnant, any buying reported being on a limited scale to meet immediate requirements. There are now only a dozen furnaces in blast in the West of Scotland, and in the unlikely event of a sudden increase of demand, smelters would find it difficult to satisfy consumers' necessities. There is, however, a steady export inquiry for Scotch pig, shipments last week amounting to 550 tons. In Lancashire the iron foundries are rapidly exhausting order-books, with a corresponding reduction of demand for pig-iron, many consumers also refraining from ordering forward in the confident hope of lower prices in the near future. So far, however, prices for Derbyshire No. 3 pig remain firm at 82s. 6d. per ton, f.o.t., while it is reported that Northamptonshire makes are now being sent to Scotland by water and can be delivered there at about 7s. 6d. per ton below the cost of Cleveland iron. On Tees-side, though there has as yet been no revival of activity, the tone of the market is distinctly more confident that an early improvement may be anticipated, inspired, probably, by the steady demand for Cleveland iron for Continental consumers. This expansion of the export trade is confirmed by the latest returns of pig-iron shipments during the current month from Tees ports, totalling up to the 21st inst. 25,605 tons, as compared with 20,713 tons for the corresponding period in March. At present there are 29 furnaces operating on the North-East Coast, but only five are producing Cleveland iron, and this barely meets requirements. No. 1 foundry and No. 4 forge are both very scarce, and with any revival of the home demand the starting of more furnaces would become a matter of urgency, as there are scarcely any stocks to draw upon. Prices generally are unchanged, but a new arrangement is now in force whereby the Cleveland makers are selling No. 3 G.M.B. iron, f.o.t. Grangemouth, at the fixed price of 97s. To other destinations the price remains 90s., f.o.b. or f.o.t. No. 1 and silicious, where obtainable, are at 85s.; No. 4 foundry, 87s. 6d.; No. 4 forge, 85s.; and mottled and white, 80s.

Quotations of East Coast hematite makers show rather a wide variation. Up to 99s. per ton is asked for mixed numbers, and 100s. for No. 1, but in other directions it can be bought for 3s. less than these figures, and there is certainly more iron on offer, notwithstanding the heavy shipments. In West Cumberland and North Lancashire the hematite trade is quiet after the holidays, Bessemer mixed numbers being quoted at £5 15s. per ton, delivered Sheffield, and ferro-manganese, for which there is a steady export as well as home demand, at £15 per ton.

Finished Iron.

The recent reduction in ironworkers' wages has affected the market for finished material to a certain extent, but so far has not resulted in any specific change in prices. In the South Staffordshire area most of the works and mills are taking a protracted holiday, pending a settlement of the engineering dispute, and very little fresh business has been booked. It is, however, reported that crown iron can now be bought at £11, but doubt is expressed as to whether there is any profit attached to that figure, and some makers are declining to quote below £11 10s. for this quality. Keen competition has developed among makers of the commoner qualities of bar iron, and it is stated that fencing iron has sold at £10 12s. 6d. Movements in marked bars have been without outstanding features of late, and as yet have not responded to the influence of the lower prices to which the material was reduced a week or two ago. It is, however, anticipated that orders will be more freely circulated now that values are so much more favourable to consumers. Business in gas strip continues dull, some of the leading makers absenting from the market on the ground that prices are unremunerative, and are devoting their attention to other lines giving a more profitable return.

Steel.

Notwithstanding the optimistic views as to an early revival of the steel industry, so freely enunciated by a certain section of the Press, the position, so far as Sheffield is concerned, has undergone little change for the better, and is in fact reported to be generally more stagnant than has been experienced for many years past. This applies more especially to those branches in which hitherto Sheffield has been regarded as unrivalled, the output of special high-grade steels, manufacturers in this department having suffered seriously by the recent abandonment of Government contracts for capital ships, with consequent heavy loss to armament firms, to whom the continued idleness of large and expensive plants must mean serious financial loss. Some improvement in the steel export trade may be noted, with a distinct increase in the volume of inquiries, most of which, however, relate to the cheaper qualities of metal, the bulk going to the Yorkshire rolling mills. Makers of mining tools also are busier, owing to the recovery in the coal trade, while some good orders for these lines are on order for South Africa. Exports of files, saws and edge tools during March have been well up to the average this season, while builders of railway rolling stock are also taking good orders in overseas markets. The recent announcement of railway orders worth several millions from an allied country still requires confirmation. On the other hand, a further announcement is now being made to the effect that the enormous sum of £100 millions is to be expended upon the restortion of Indian railways. If this be a fact, there should follow a heavy inflow of orders for rolling stock, permanent-way materials and general railway requirements sufficient to make its effect felt throughout the length and breadth of this country. The North-East Coast steelworks have been idle all the week, and at best are still only working intermittently. Orders are all for small quantities, and works are simply kept going from hand to mouth. Prices are all unchanged.

Scrap.

The various markets for scrap iron and steel continue in a disturbed condition, buying being practically suspended on the part of merchants and consumers pending the outcome of the present industrial troubles. South Wales may, however, be excepted from the general rule of slackness in the scrap trade, renewed activity in the tinplate industry having induced a corresponding expansion of demand for this class of raw material, especially for heavy steel qualities, which are now offered at 67s. 6d. to 72s. 6d., with heavy steel turnings readily taken up at figures between 54s. and 58. Bundled steel scrap and shearings are in good demand and are firmer at 55s. to 67s. 6d., according to quality and methods adopted in bundling. Mixed wrought-iron and steel scrap is receiving more attention, and the demand for the heavy and better quality material is stronger at 57s. 6d. to 65s., while there is no change in the lighter classes, which are obtainable at 30s. to 35s. Heavy cast-iron scrap in lumpy pieces and furnace sizes is quiet but firmer at 70s. to 75s. Good machinery scrap in cupola sizes, although quiet, is firmer at 80s. to 85s.

Foundry Coke.

Consumption of this class of fuel has been obviously restricted of late by holiday influences, the various markets for foundry coke having experienced a quiet time, although prices have been fairly well maintained. On Tyneside quotations rule firmly at 34s. at ovens, the same quotations applying to the Midland Counties and South Wales, with 22s. 6d. quoted for blast-furnace descriptions.

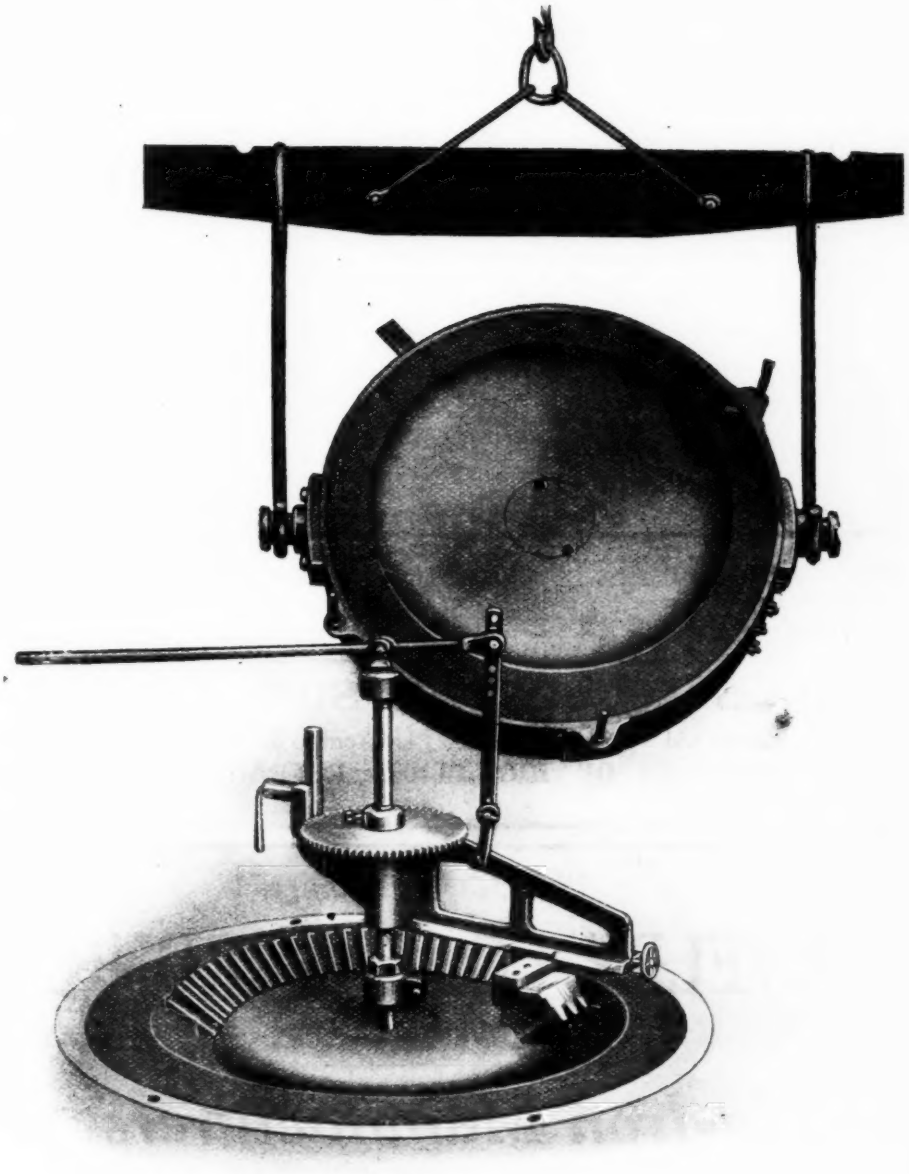
Ferro-Alloys.

The market for ferro-alloys, especially as applies to materials for high-speed and special steels, continues extremely quiet, consumers being still in possession of heavy stock accumulations acquired some time ago. Ferro-tungsten is quite flat, and also ferro-molybdenum, but vanadium has received more attention for export. Ferro-chrome, both refined and high-carbon, are becoming quite nominal in the absence of business. Fairly heavy stocks are still held, especially in the 4/6 per cent. grade. Ferro-manganese and spiegel remain unchanged, although easier in demand on account of the lock-out. Ferro-silicon, however, has received a little more attention, and inquiries for both 45 per cent. and 75 per cent. grades are about, a few orders having been placed for moderate quantities. Prices have been substantially unaltered. Silico-manganese is receiving a good deal of attention, but no great weight is being booked up.

(*Continued on page* 320.)

The "VULCANIA" PATENT WHEEL MOULDING MACHINE.

Patent No. 5049.



THE "VULCANIA" PATENT WHEEL MOULDING MACHINE is for moulding spur wheels with straight, sloping or Vee-shaped teeth, also bevel wheels, skew gear wheels, worm wheels and internal wheels. The machine head is carried on a pillar which is held in a base-plate bedded in the floor sand, and is made to slide on the pillar by means of a lever and link carried on a joint bearing, or by rack and pinion, or screw if thought advisable for the particular work it is being used for.

An adjustable stop collar is provided for accurately deciding the depth of mould. On the removable head a slide is carried for supporting the patterns of the teeth to be moulded. This slide is made adjustable by screw or pinion gearing to the diameter required. The number of teeth to be moulded is decided by a special dividing plate into which a steel wedge or finger engages. The special dividing plate has milled vees, at the angle of 60° inclusive, around its circumference, to receive the steel wedge, which is adjusted by a screw having an internal spring to keep it in tension and to lock the head when ramming operations are being carried out.

JAMES EVANS & CO., BRITANNIA WORKS,
(MANCHESTER), LIMITED,
BLACKFRIARS, MANCHESTER.

IRON AND STEEL MARKETS.—*Continued.*

Tinplates.

Business in the tinplate market during the past week was obviously on a somewhat restricted scale, owing to holiday observance, but, notwithstanding, the improved conditions recently noted were well maintained, the volume of inquiries both on home and export account continuing on a satisfactory scale. The demand, however, has been mostly for prompt delivery, although some special option contracts have been placed for June-July shipment. I.C., 14 by 20, 112 sheets, 108 lbs., coke tins rule firm at 19s. 6d. to 19s. 9d. per box, net cash, f.o.b. Wales, while 28 by 20 in double boxes are held at 39s. and upwards.

Metals.

Copper.—Steady and firm will fairly describe the conditions ruling of late in the standard copper market, and given a better political and industrial outlook, an early return of confidence could be safely predicted. American consumption has recently been on a more satisfactory scale, and the surplus stocks have doubtless been further substantially reduced during last month. Total American deliveries this quarter should be heavy, considering that the sales effected in March were estimated at between 75,000 and 85,000 tons. New copper is becoming available in America in marketable form at the rate of about 35,000 tons a month, but the increase in output is slow and not expected to be very large for some time to come. Closing prices:—Cash: Wednesday, £58 15s.; Thursday, £59 2s. 6d.; Friday, £59 12s. 6d.; Monday, £59 7s. 6d.; Tuesday, £59. Three months: Wednesday, £59 7s. 6d.; Thursday, £59 15s., Friday, £60 5s.; Monday, £60 2s. 6d.; Tuesday, £59 12s. 6d.

Tin.—A strong buying movement was in evidence in last week's market for standard tin, at one stage carrying the value for forward metal to £158, due in a measure to a more favourable outlook in the Far East. Prospects in the South Wales tinplate trade are also regarded as improving, while a much heavier consumption demand is anticipated in the States. Sales of Eastern tin at the advance have been substantial, and probably to a good extent for shipment to America. Including the larger shipments made recently from Java, the total supplies for April will probably show an excess against the tonnage accounted for March, but the probability is that the world's deliveries will again pan out satisfactory. Closing prices. — Cash: Wednesday, £151 15s.; Thursday, £153 2s. 6d.; Friday, £155 15s.; Monday, £153 5s.; Tuesday, £151 10s. Three months: Wednesday, £153 2s. 6d.; Thursday, £154 10s.; Friday, £157 5s.; Monday, £154 15s.; Tuesday, £153.

Spelter.—Business in this section of the metal trade is marked by a steady tone, an expansion of demand being due to the improvement in the galvanising industry, sales in the market being on a more satisfactory scale. Some forward business has been effected. April sellers quoting £26 17s. 6d. May, £26 15s. June, £26 13s. 9d. Closing prices.—Ordinary brands: Wednesday, £26 17s. 6d.; Thursday, £26 17s. 6d.; Friday, £27; Monday, £27 15s.; Tuesday, £27 7s. 6d.

Lead.—Buying in the market for soft foreign pig last week was on an active scale, both on home and export account, and prices have steadily advanced. English metal has also appreciated. English closing prices: Wednesday, £24; Thursday, £24 5s.; Friday, £25: Monday, £25 5s.; Tuesday, £25 10s.

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